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ERRATA

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Page 1 add to footnote 2 LEROY F PATTON, *The sandstone dikes around Rockwall, Texas* Hollands Mag (Dallas) **44**(6): 5, 86 June, 1925

Page 185, line 1 for "moldings and" read "molding sand"

Page 187, line 8 for "0 2πr" read "2πr"

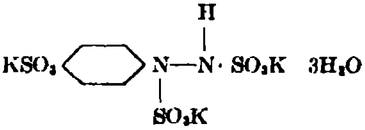
Page 212, line 29 for "Leon Pièrre" read "Léon Pierre"

Page 327, line 7 for "components" read "*component S*"

Page 340, move second paragraph to top of page so that it becomes part of proceedings of 701st meeting

Page 442, line 1 delete inferior 4 and read "*1-Hydroxybenzene-4-diazosodiumsulfonate*"

Page 443, line 24 the graphic formula should read



$$KSO_3C_6H_4N(SO_3K)\text{—}N(H)\cdot SO_3K\ \ 3H_2O$$

JOURNAL
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VOL. 17 JANUARY 3, 1927 No. 1

GEOLOGY.—*On the origin of the "rock wall" at Rockwall, Texas.*[1] L. W. STEPHENSON, U. S. Geological Survey.

There is in Texas, about 20 miles northeast of Dallas, a town by the name of Rockwall, the county seat of Rockwall County. The town derives its name from a natural feature which is locally called the "rock wall." Mr. Sidney Paige[2] investigated the "rock wall" in 1909, and the following paragraphs are quoted from his account of it:

> For many years reports of a more or less definite nature have been circulated describing the wonders of the ancient wall surrounding the town of Rockwall, Texas. The writer was able during the past winter to spend a few days investigating this supposed historic structure. It proves to be not a wall, but a number of disconnected sandstone dikes, strictly speaking, not surrounding the town, but trending in many directions. As exposures are few, they have been discovered in such scattered localities in the town's environs as to suggest the idea that they were fragments of a ruined wall.
>
> * * * *
>
> Though good exposures are infrequent, owing to the depth of the soil, a peculiar condition affords ample opportunity to observe the dikes in place. These latter are natural courses for underground waters, and wells are often located on them. Though these wells are filled with water, the rock forming the dike, removed during the sinking of the well, may be examined at leisure.

I have recently had an opportunity to examine one of the so-called rock walls at a locality at the west edge of the town at a point where it intersects the Dallas-Greenville road. The town is located at the crest of the west-facing slope of the valley of the East Fork of Trinity River (sometimes called Bois d'Arc Creek), south of the valley of

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[1] Published by permission of the Director, U. S. Geological Survey, Washington, D. C. Received November 30, 1926.

[2] PAIGE, SIDNEY, *The "rock wall" of Rockwall, Texas.* Science n. ser. 13: 690-691. 1909.

Squabble Creek. The wall where I saw it intersects the road about a quarter of a mile west of the center of the town, at an altitude 45 or 50 feet lower than the top of the hill. The owner of the land at this place has made several excavations along the side of the wall, which here trends several degrees west of north, and an appropriate sign at the side of the road invites the interested traveller to view the ancient archaeological structure, which he is permitted to do after the payment of a small entrance fee.

Paige's interpretation, that the wall is not an artificial structure but is in the nature of a sandstone dike, is doubtless correct, but his explanation of the cause of its wall-like appearance needs modification. He says:

> The dikes are of various sizes, varying from an inch in thickness to eighteen inches or two feet. They stand vertically, or nearly so, and have in cases been followed downward fifty feet or more, always imbedded in the lime muds. They are composed of exceedingly fine-grained quartz sands, cemented by calcium carbonate So far as observed they do not vary appreciably in width through vertical range Two joint systems, one nearly horizontal, the other vertical, have cut these dikes in such a manner as to suggest masonry walls, i e, they are composed of oblong blocks in horizontal layers

The "wall" which I saw is not a solid sandstone dike broken by horizontal joints, but is composed of a series of alternating, more or less lens-like horizontal layers of clay and sandstone. The clay layers reach a maximum of an inch or more in thickness, and the sandstone layers may attain a thickness of as much as 6 or 8 inches. The sandstone beds are cut by vertical joints perpendicular to the face of the wall. Some of the sandstone layers thin down and pinch out in a lens-like manner, and some of them divide into two layers separated by clay. The combination of horizontal bedding and vertical jointing in the sandstone layers, gives to the dike its masonry-like appearance. The relatively thin clay layers simulate the mortar of an artificial wall. The vertical joints are irregularly distributed and do not occur in the form of "broken joints," as would be expected in a true masonry wall. Two views of the dike are shown in plate 1.

Paige did not reach a definite conclusion as to the origin of the dikes. He states that the fissures may have been due to drying or to earth movements, and that the material filling them may have come from below or from above. The fissures are too deep, I think, to have been formed by desiccation from the surface downward. Earth movements that produced and widened joints into fissures seem adequate to account for them. Since the dikes are horizontally stratified the materials must have been washed in from above and were probably deposited in standing water in the fissures. The fissures must have remained open during the time they were being filled with clay and sand. If the fissures were opened on a land surface, and were filled by

A View of one of the sandstone dikes or rock walls in an excavation on the east or up-slope side, at the west edge of Rockwall town, the dike has here been disturbed by soil creep which has tipped it over, least below, most above, widening the spaces between the hard sandstone layers

B. View of the same dike in an excavation on the down-slope side where the clay and sand layers are in undisturbed relation to each other, showing the lenslike character of the sandstone layers, the argillaceous chalk or chalky marl which is cut by the dike is shown on the left.

sediments carried by surface water, one would expect strong cross bedding in the dikes with some coarse foreset beds similar to the bedding found in delta deposits, and he would expect the sediments to be mixed with oxidized substances, leaves, seeds, sticks, bones, and other surficial materials. Instead the sediments are clean and uniform with the exception of the scattered fragments of gray unoxidized clay, and I am therefore inclined to the opinion that the fissures were formed under water, probably that of a shallow sea during the latter part of Upper Cretaceous time.

The dike at the west edge of Rockwall cuts the Pecan Gap tongue of the Annona chalk, of Upper Cretaceous age, which here consists of argillaceous chalk or chalky marl, nearly free from sand. Two or 3 feet below the surface the chalk is practically fresh, showing only slight signs of weathering and oxidation. The chalk forms the upper part of the west-facing slope of the hill and the only source of sand that seems adequate to furnish the sandy material of the dike is the Wolfe City sand member of the Taylor marl, which in the next county to the north lies stratigraphically beneath the chalk. I have not seen the Wolfe City sand in the immediate vicinity of Rockwall, but it probably underlies the chalk there. Paige mentions "thinly bedded flaggy sandy limestone" near Rockwall, but does not give the exact locality. The beds of the Pecan Gap chalk at this locality dip at a low angle toward the east, so that the Wolfe City sand, if present, may have come to the surface within a few miles to the west, where it was subject to erosion at the time the dikes were formed in late Cretaceous time.

The sandstone layers consist of medium-grained gray calcareous sand cemented with calcite. Scattered through the sand composing the sandstone layers are considerable numbers of mechanically included clay fragments, the largest noted being about three-fourths of an inch long.

Mr. C. S. Ross has examined thin sections made from one of the sandstone layers and he describes it as follows:

> The sand grains are predominantly quartz, but there are many grains of feldspar and chert, and a very few of muscovite. Most of the grains are sharply angular but some are subangular. A few are well rounded or have one border that is well rounded and the other angular, as if rounded grains had been fractured The calcite cement has replaced or corroded some of the sand grains and especially the feldspar. A veinlet of calcite cuts one of the sections

Mr. Ross also examined a thin section made from a sample of the Wolfe City sand from near Wolfe City, about 40 miles northeast of Rockwall, and he says of it:

> The mineral grains are predominantly quartz, but smaller amounts of feldspar, mica, and other minerals, are present. The grains are sharply angular for the most part. The cementing material is finely granular calcite. The sand grains average about 0.05 mm. in diameter.
>
> Compared with the material from the dike this sample of Wolfe City sand is quite similar in type and angularity of the sand grains, and the inclosing calcite is somewhat similar in habit. The sand grains differ greatly in size, however, since those in the dike average about 0.2 mm., while those in the Wolfe City specimen are only 0.05 mm. in diameter.

So far as the evidence goes, therefore, the sand composing the dikes might well have been derived from the Wolfe City sand, but the samples compared are geographically too far apart to warrant basing a final conclusion upon them.

PALEONTOLOGY.—*On the type skull of* Equus laurentius *Hay.*[1]

OLIVER P. HAY, U. S. National Museum.

In 1913[2] the writer described as belonging to a new species of *Equus* (*E. laurentius*) a nearly complete skull which had been found on a sandbar of Kansas River, near Lawrence, Kansas. Prof. J. E. Todd told the writer that with this skull were picked up the base of an antler of an elk and the femur of a carnivore. The femur was regarded by Dr. Roy E. Moodie as belonging probably to a species of *Smilodon*.

In an excellent paper published recently[3] entitled "The evolution of the horse: A record and its interpretation," Dr. W. D. Matthew, of the American Museum of Natural History, on his page 181, mentioned, with other species, *Equus laurentius* and added as follows: "The last is based upon a recent skull mistakenly supposed by the author to be of Pleistocene age." No reasons were given for this statement. On reading this the writer became anxious to see that skull once more and to determine for himself whether or not he had fallen into error. The skull is now in the temporary possession of Dr. Childs Frick, of the American Museum, New York, and on the writer's request Dr. Frick generously sent the specimen.

It appears to the writer that two questions are involved. First,

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[1] Received Nov. 2, 1926.

[2] Proc. U S. Nat. Mus 44: 584–591 *Pl. 72, 73* 1913.

[3] Quart Rev. Biol. 1: 139-185 1926

is the skull of Recent or of Pleistocene age? Second, is it specifically identical with any of the breeds of the domestic horse, *Equus caballus?*

In case the skull is that of a modern horse it must have been buried within 300 years or less; also very near the place of discovery, for, excepting the loss of the free portions of the nasal bones, it shows no abrasions. Furthermore, the lower jaw was found with the skull. Without doubt it had been buried in a river deposit, either of sand or possibly of sandy muck. Under such conditions one would expect a modern skull to be little or not at all mineralized, to be soft and friable, and to be of relatively light weight on drying out. Often bones of elephants, mastodons, and horses, which have been in such deposits since the early Pleistocene are so soft that they must be handled with the greatest care to prevent crumbling.

Now, the skull found at Lawrence is in no such condition. The specimen, skull and lower jaw, is heavy, charged and colored with iron carbonate, and hard. When an area of the skull has been covered many hours with a pad of wet paper the bone does not soften, as it might be expected to do. It seems to the writer that the conditions for fossilization must have been extraordinarily favorable in order that a skull might, within 300 years, reach such a stage of preservation.

Does the type of *E. laurentius* present characters which distinguish it from *Equus caballus?* The skull is that of one of the smaller horses, the basilar length being 490 mm. (not 481). It has been spoken of as an "Indian pony." It ought to be compared with the smaller breeds of the domestic horse. Unfortunately there is, in the U. S. National Museum, no good specimen of the small horses from the western plains, and probably there is none in the American Museum. At hand is a skull obtained in Arizona by Dr. Walter Hough, of the U. S. National Museum. It is weathered and somewhat damaged.

The writer has taken renewed measurements of the skull from Lawrence and measurements of the Arizona skull. From these measurements have been determined the indices of the important parts according to Prof. H. F. Osborn's method;[4] and the corresponding indices have been compared. They have also been compared with indices obtained from the skulls of *Equus lambei* from Alaska, *Equus niobrarensis*, and *Equus przewalskii*. All of these forms show differences in the structure of their skulls, but these differences are small and apparently might fall within individual variations. The writer believes that no one would, without other characters, base a species on such closely similar indices; nor would one, because of these resemblances, refer all of these horses to one species. We seem still compelled to depend on the structure of the teeth and on variations in size of the animals.

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[4] Mem Amer Mus Nat Hist. new ser 1: 85 1912.

The upper cheek teeth are present in the Arizona horse, but they are somewhat shattered, and the second premolars are missing from their sockets. The teeth of the two horses are in about the same stage of wear. The tooth line measures the same in both and the individual teeth are of practically the same size in the two. In both horses the protocones are short. The postprotoconal valleys appear to differ in that those of the Arizona horse are directed more strongly outward than in *E. laurentius*. The fossettes of the latter are markedly broader than those of the Arizona horse, and the enamel which surrounds the fossettes is little folded. The hinder one has a very shallow infold in the rear and another in front. Except this, the front wall of the hinder fossette has no undulations. The front wall of the anterior fossette may or may not have a shallow infold; in its inner hinder corner is an M-shaped infold. In the case of the fossettes of *E. laurentius* the confronting lines of enamel are considerably more folded than in the Arizona horse and the complication somewhat exceeds that of a large domestic horse at hand.

The writer believes that the type skull of *Equus laurentius* is a real fossil and that it belonged to a horse of probably early Pleistocene age. It appears only fair that those who regard it as a part of a modern horse shall present evidences therefor.

BOTANY.—*New plants from Central America.*—*VI.*[1] PAUL C. STANDLEY, U. S. National Museum.

The new species of plants, chiefly trees and shrubs, described here are all natives of Panama or Costa Rica, and most of them have been collected by myself during the past two years. The Panama species are probably the only new ones awaiting description from the region of the Canal Zone previous to the publication of a flora of that area.

Most interesting of the new plants described is *Parmentiera Valerii*, a large tree belonging to a group hitherto represented in Central America by only two known species, both of which are trees much inferior in size to this one.

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[1] Published by permission of the Secretary of the Smithsonian Institution. For the last preceding paper of this series see This JOURNAL 15: 472 1925 Received Nov. 2, 1926.

Lacistema pedicellatum Standl., sp. nov.

Shrub or tree 2–7.5 meters high, the branchlets slender, terete, when young densely strigillose; stipules lance-triangular, 1.5–2 mm. long; petioles slender, 3–8 mm. long, strigillose; leaf blades elliptic-oblong or obovate-oblong, 8–11.5 cm. long, 2.5–4 cm wide, cuspidate-acuminate, with acute or obtuse tip, cuneate to obtuse at base, membranaceous, remotely and obscurely serrulate, green and glabrous above, paler beneath, sparsely and minutely strigillose, densely pilose along the costa and in the axils of the lateral nerves; racemes solitary in the leaf axils, 3.5–6.5 cm long, slender, laxly flowered, the rachis densely sordid-hispidulous, the bracts puberulous, much shorter than the pedicels, the pedicels 1–2 mm. long, glabrous; sepals 3 or 4, broadly rounded, glabrous, disk large, 4-lobate; stamen glabrous, the cells divergent; ovary very sparsely setose, the style short, the stigmas 3, longer than the stamen; fruit subglobose, 4 mm. in diameter, sparsely puberulent; seeds 3.

Type in the U. S. National Herbarium, no. 679251, collected along the Río Culebra above Santa Isabel, Province of Colón, Panama, near sea level, Aug. 10, 1911, by H. Pittier (no. 4152). Collected also on hills north of Frijoles, Canal Zone, Dec 19, 1923, *Standley* 27426.

The most closely related species is *L. Pittieri* Blake, of Venezuela Both are marked by the pedicellate flowers, those of most species being sessile in the bracts *L. Pittieri* differs from the Panama plant in its densely hispid ovary and entire leaves.

Heisteria longipes Standl, sp. nov.

Glabrous shrub, the branchlets slender, green; petioles slender, 7–12 mm. long; leaf blades elliptic to elliptic-oblong, 8–12 cm. long, 3–6 cm. wide, abruptly obtuse-acuminate or obtuse, acute at base, thin, the lateral nerves 7 to 9 on each side, slender; pedicels in fascicles of 2 or 3, slender, 1–1.5 cm. long, fruiting calyx rotate, purplish red, 2 cm. broad, subentire; petals 6, ovate-deltoid, acute; stamens 12, slightly longer than the petals; fruit oval, 8 mm. long

Type in the U. S National Herbarium, no. 679090, collected along the Trinidad River, Canal Zone, Panama, July, 1911, by H. Pittier (no. 4006).

The leaves are much like those of *H. macrophylla* Oerst., the most widely distributed species of Central America, but in that the pedicels are shorter than, or rarely equal, the fruiting calyx.

Heisteria latifolia Standl., sp. nov.

Small tree, 4 meters high, glabrous, the branchlets obtusely angulate, green; petioles thick, stout, about 2 cm. long; leaf blades elliptic or broadly elliptic, 27–32 cm. long, 12–15 cm. wide, acuminate, rounded or obtuse at base, subcoriaceous, lustrous above, the lateral nerves about 16 pairs, subarcuate, anastomosing near the margin; pedicels usually geminate, 1 cm. long; fruiting calyx subentire, rotate, red, 2–2.5 cm. broad; fruit oval, 12 mm. long.

Type in the U. S. National Herbarium, no 679256, collected along the Río Culebra above Santa Isabel, Province of Colón, Panama, near sea level, Aug. 10, 1911, by H. Pittier (no. 4156).

Distinguished from all the other Central American species of the genus by the very large, broad leaves, borne on comparatively long petioles.

Hydrangea inornata Standl., sp. nov.

Scandent shrub, the branchlets terete, covered with brown, longitudinally sulcatulate bark, when young tomentulose, the internodes elongate; petioles 1–2 cm. long, glabrous; leaf blades elliptic or oblong-elliptic, 8–23 cm. long, 3.5–11 cm. wide, acutely acuminate or abruptly contracted into a short acumen, acute or subobtuse at base, coriaceous, entire, glabrous on both surfaces, the lateral nerves 5 to 8 on each side, arcuate, prominent beneath, the ultimate nerves closely reticulate, prominulous beneath; inflorescences ample, short-pedunculate, 5–9 cm. broad, the cymes umbellately arranged, many-flowered, the rachises stellate-tomentulose, the axes of the first order 1–3 cm. long, equaling or surpassing the rest of the cyme, the pedicels 1–4 mm. long or the flowers sessile; flowers all fertile, pink; sepals 4, much broader than high; petals 4, 2 mm. long; stamens 8, the filaments 1.5 mm. long, the anthers small; styles 3 or 4; hypanthium broadly cup-shaped, glabrous, 1.5 mm. wide.

Type in the U. S. National Herbarium, no 577962, collected in forests at Tuis, Atlantic slope of Costa Rica, altitude 700 meters, December, 1900, by H. Pittier (no. 14068).

This Costa Rican plant appears to be related to *H. ecuadorensis* Briq , and belongs to the Section *Cornidia*, Subsection *Monosegia* B. *Aphananthae*, as outlined by Briquet.[1]

Aside from the Panama species here described, only one other *Hydrangea* is known from Central America, *H. Oerstedii* Briq., which is frequent in the higher mountains of Costa Rica. It is a large woody vine with broad cymes which bear numerous bright pink sterile flowers. It is a very handsome plant when in full flower, and quite as showy as the cultivated hydrangeas.

The juvenile plants of *H. Oerstedii* are very different in general appearance from the adult ones. They are very slender, with coarsely toothed leaves only 1 to 3 cm. long. These juvenile plants are abundant nearly everywhere in the mountains of Costa Rica, closely investing tree trunks and even fence posts. The writer for several years has been familiar with this form, and had often wondered to what family it might belong. It was only during the past winter, after close study, that the true relationship of this juvenile form was recognized, and even then it was hard to credit the evidence, so different in aspect are the two states of the plant. The juvenile plants are many times more plentiful than adult ones.

In 1922 I collected in Salvador on the Volcano of San Salvador juvenile plants of this genus, but at that time did not recognize their relationship The Salvador plant may be the immature form of *H. Oerstedii*, or perhaps it belongs to a species not yet described.

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[1] Ann. Cons. Jard. Bot. Genève 20: 396. 1919.

Hydrangea panamensis Standl., sp. nov.

Shrub, the branchlets terete, brown, when young appressed-stellate-tomentose, the internodes short; petioles stout, 1–1.5 cm. long, stellate-tomentose; leaf blades oblong, elliptic, or ovate, 8–10.5 cm. long, 3–4.5 cm. wide, obtuse at apex or rounded and emarginate, obtuse at base, coriaceous, entire, above dark green, furnished with remote microscopic appressed stellate scalelike hairs, beneath brownish, sparsely and microscopically stellate-pilose, the lateral nerves about 6 on each side, straight, laxly anastomosing close to the margin, prominent beneath, the reticulation of the ultimate nerves inconspicuous; inflorescences dense, pedunculate, 3.5 cm. broad; bracts caducous, 1.5–2 cm. long, rounded at apex, stellate-tomentose on the outer surface; axes of the first order umbellately arranged, about 1 cm. long, densely brown-tomentose, about as long as the upper part of the cyme; flowers sessile or short-pedicellate; sepals 4, broadly triangular, obtuse, broader than long; petals 4, rounded, 2 mm. long, glabrous; stamens 8; styles 3 or 4; hypanthium campanulate, glabrous, rounded at base, 1.5 mm wide.

Type in the U. S. National Herbarium, no 678998, collected along the Río Fató, Province of Colón, Panama, near sea level, July, 1911, by H. Pittier (no. 3919).

The collector reports that the plant was epiphytic upon a *Sloanea* tree. The corolla is described as yellow, and the bracts and calyx as purple.

This *Hydrangea* is noteworthy in its habitat, since most of the tropical American species occur only in the high mountains The Panama species belongs to the same group as *H inornata*, and in Briquet's key to the species would run to *H. Mathewsii* Briq , a Peruvian plant with rugose-nerved, obovate, crenate-denticulate leaves.

To *H. panamensis* are to be referred, probably, juvenile specimens collected by the writer (no 27431) near Frijoles, Canal Zone, in 1923.

Erythrina panamensis Standl , sp. nov

Shrub or tree 1–6 meters high, the young branchlets whitish-sericeous; branches armed with stout conic prickles; petiole and rachis at first sericeous but soon glabrate, the petiole sometimes prickly; leaflets deltoid to ovate-deltoid, the terminal leaflet often rounded-deltoid, 11–24 cm long, 6 5–18.5 cm. wide, abruptly or gradually acuminate or long-acuminate, entire, thin, above bright green and glabrous or glabrate, beneath pale, sericeous with slender straight whitish hairs; racemes about 12 cm. long, the rachis tomentulose, the pedicels 2–4 mm long, calyx 14–17 mm long, tubular-campanulate, 5–6 mm. thick, minutely strigillose with whitish hairs or almost wholly glabrous, the margin shallowly bilobate, the lobes subequal, rounded, standard red, glabrous, linear-oblong, obtuse, about 6 cm long, 1 cm. broad, attenuate at base; keel petals cohering above, 11–12 mm. long; pod long-stipitate, 11–20 cm. long, about 1 5 cm. thick, 4 to 13-seeded, strongly and abruptly constricted between the seeds, at first densely whitish-sericeous, later glabrate; seeds red, about 9 mm. long, 6 mm. thick.

Type in the U. S National Herbarium, no. 677253, collected about the Agua Clara Reservoir near Gatún, Canal Zone, Panama, February 5, 1911, by H. Pittier (no. 2656).

The following Panama collections represent the same species: Río Indio de Gatún, Canal Zone, *Maxon* 4808 Near Gatún, *Goldman* 1854. Barro Colorado Island, Canal Zone, *Standley* 31352. Cana, *Williams* 782 Between Gorgona and Gatún, *Pittier* 2287.

The writer previously[3] referred most of this material to *E. costaricensis* Micheli, but more ample Costa Rican material of that species proves that the Panama *Erythrina* is distinct. *E. costaricensis* may be distinguished readily by the loose matted tomentum of the leaves.

DYSOPSIS GLECHOMOIDES (Rich.) Muell. Arg.

It seems worth while to record here the occurrence in Costa Rica of *Dysopsis*, a monotypic genus of the family *Euphorbiaceae*, not reported previously north of the Andes of Ecuador. Specimens were collected by Prof Juvenal Valerio and the writer (no. 43770), Dec. 31, 1925, on the Cerro de las Vueltas, Province of San José, Costa Rica, at an altitude of 3,000 meters. The plant is an inconspicuous succulent herb, growing in wet forest.. Various writers have stated that in general appearance it resembles *Hydrocotyle*, but when growing it scarcely suggests that genus, although it does have a striking resemblance to certain species of *Pilea*.

Euphorbia Valerii Standl , sp. nov.

Slender shrub 3–4.5 meters high, sparsely branched, glabrous throughout the branches about 1 cm. thick at apex and bearing there a few leaves, densely covered with the scars of the fallen leaves, leaves alternate, the petioles stout 1.5–2 5 cm. long; leaf blades narrowly oblanceolate-oblong, 35–40 cm. long 9–10 cm wide, entire, obtuse, gradually narrowed from near the apex to the acute base, abruptly decurrent upon the petiole, the lateral nerves obsolete; peduncles arising in the axils of the uppermost leaves, stout, 18–24 cm. long; flowers numerous, the pedicels 1–1.5 cm. long, arranged in 3 or 4 times dichotomous cymes 7 cm. long and 9 cm. broad, bracts of the inflorescence caducous, not seen, involucre broadly campanulate, reddish, about 7 mm. long, 10 mm. wide, the lobes ovate-quadrate, their margins laciniate, styles united almost to the apex, immature capsules subglobose, more than 1 cm. in diameter.

Type in the U S. National Herbarium, no. 1,251,433, collected in wet forest at Los Ayotes, in the Sierra de Tilarán, Guanacaste, Costa Rica, altitude about 700 meters, Jan. 21, 1926, by Paul C Standley and Juvenal Valerio (no 45338).

Euphorbia Valerii is referable to Boissier's group *Laurifolia*, which has been recognized by some botanists as a separate genus, *Euphorbiodendron*. No species of this group has been reported from Central America. *Euphorbia Sinclairiana* Benth , described from Gorgona Island, Colombia, is, to judge from its description, closely related to the Costa Rican plant, and it may be that the two are conspecific The involucres in *E Sinclairiana* are described as smaller, and the leaves as acutely short-acuminate.

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[3] Contr U. S. Nat. Herb. 20: 180 1919

Only two or three plants of *E. Valerii* were found, growing in very dense and wet forest. The branches, when broken, yield a copious flow of white latex. The sap of the related species of Mexico is known to cause blistering and painful inflammation of the skin.

Loasa grandis Standl., sp. nov.

Coarse herb 1.5–2.5 meters high, branched only above, the branches stout, hollow, hispid with slender divaricate stinging hairs, and covered with dense, very short hairs hooked at apex; leaves alternate, the petioles 4.5–7 cm long, pubescent like the stems; leaf blades in outline elliptic or ovate-elliptic, 16–30 cm long, 12–24 cm. wide, the uppermost much reduced, acute or acuminate, at base rounded to shallowly cordate, shallowly lobed, the lobes 4 or 5 on each side, broadly triangular, obtuse or acute, irregularly dentate; leaves thin, above along the nerves short-hispid, scabrous, beneath hispid along the costa, furnished along the nerves with slender nail-shaped hairs, elsewhere scaberulous, flowers numerous, arranged in a large much-branched panicle bearing a few reduced leaves, the pedicels 2–3 cm. long; sepals broadly ovate, about 1 cm. long, acute, 5 or 7-nerved, sparsely serrate-dentate, scabrous; petals pale green, cucullate, almost orbicular, about 3 cm. long, rounded at apex, furnished on both sides with minute nail-shaped hairs; scales oval, petaloid, 7 mm long, 4 mm. wide, broadly rounded at apex, glabrous, bearing outside below the apex 3 small conic appendages; staminodia 2 opposite each scale, linear-attenuate, about equaling the filaments, ciliate at the middle; stamens numerous, the filaments free, glabrous, inserted continuously between the staminodia, 1 cm. long; anthers oblong, almost 2 mm. long; ovary 1-celled, densely hispid, with 5 parietal placentae, the ovules numerous; style columnar, about 12 mm. long, the stigma obtuse; immature capsule more than half superior, the free portion hispid with very slender, short hairs.

Type in the U. S National Herbarium, no 1,251,425, collected in wet forest near Tilarán, on the road to El Silencio, in the Cordillera de Tilarán, Guanacaste, Costa Rica, altitude about 625 meters, in January, 1926, by Paul C. Standley and Juvenal Valerio (no. 44558).

The plant seems to be rare, since it was seen only once in the several weeks spent in exploration of the Cordillera of Tilarán. The large flowers are rather handsome

This has little in common with the two other species of *Loasa* known from Costa Rica. Of the latter, *L. speciosa* Donn Smith is known only from the volcanoes of Irazú and Turrialba and the adjacent slopes Its orange-yellow bell-shaped flowers are about 6 cm. long, and very showy, but they are well protected, since the long hairs, as in other species of the genus, sting quite as painfully as any nettle. On Irazú this species is known as "campana" and at Las Nubes it is called "ortiga veinticuatro." The latter name is given because the pain from the sting is said to last 24 hours.

The other Central American species has been described as *Loasa bipinnata* Donn. Smith, but it appears to be only one of the forms of *L. triphylla* Juss., which is widely distributed in South America. Above the Isthmus of

Panama it is known from Chiriquí in Panama and from Costa Rica and Veracruz. In many parts of Costa Rica it is an abundant and pernicious weed of the forests. Many are the anguished exclamations I have heard from companions on botanical excursions who have brushed against the plant, for the stiff hairs penetrate ordinary clothing with the greatest ease In Costa Rica this plant often is called "ortiga" (nettle), but the more usual name is "pringamosca," evidently a corruption of the term "pringamoza," which is given elsewhere in Mexico and Central America to various stinging plants.

Ardisia myriodonta Standl., sp. nov.

Plant woody or suffrutescent, 0.3–1 meter high, the branchlets terete, stout, glabrous, toward the apex minutely brown-punctate, petioles slender, 8–16 mm. long, glabrous, leaf blades oblong-elliptic, 12–25 cm. long, 4.5–9.5 cm. wide, subabruptly short-acuminate, long-attenuate toward the base, thinly membranaceous, glabrous, along the margin densely red-punctate, the lateral nerves about 18 on each side, subarcuate, prominent beneath, the margin pectinate-serrate, the teeth very numerous, close-set, very narrow, attenuate, unequal; inflorescence small, sessile, 3.5 cm long, many-flowered, dense, tripinnately paniculate, the flowers subcorymbose, the pedicels 3–5 mm. long, glandular-lepidote, the bracts deciduous; sepals 5, nearly free, lance-oblong, attenuate, 2 mm. long, densely punctate, very minutely ciliolate-dentate; fruit globose, black, 6 mm in diameter, glabrous, sparsely verruculose-punctate.

Type in the U. S National Herbarium, no. 1,251,625, collected on Barro Colorado Island in Gatún Lake, Canal Zone, Panama, November, 1925, by Paul C. Standley (no. 40848). No. 40841 from the same locality also represents the species

Related, according to description, to *A. pellucida* Oerst., of Mexico and Guatemala, which has longer petioles and broadly ovate sepals. Flowers of the Panama plant are, unfortunately, not available It is remarkable for its low stature, most of the Central American Ardisias being large shrubs or small trees.

Vincetoxicum pinguifolium Standl., sp. nov.

Large scandent herb, the branchlets terete, densely covered with minute divaricate hairs and sparsely divaricate-hirsute with hairs about 2 mm. long; petioles slender, 2–4 cm. long; leaf blades rounded-ovate, 5.5–9 5 cm long, 3–7 cm. wide, abruptly short-acuminate, deeply cordate at base, the sinus narrow, the basal lobes broadly rounded, the blade multiglandular at base, green above, paler beneath, on both sides soft-pubescent with very minute, dense hairs, the lateral nerves about 5 on each side, prominent beneath, inflorescences umbelliform, few-flowered, the peduncle 6–16 mm. long, the pedicels 10–25 mm. long, minutely pubescent, the bractlets subulate, 2–3 mm. long; calyx lobes lance-ovate, acute, 3 mm. long, minutely pubescent outside; corolla reddish brown, minutely puberulent outside, within pilose with few long white hairs, deeply lobate, the lobes 6 mm. long, ovate, obtuse. corona shorter than the gynostegium, annular, fleshy, black, irregularly corrugate; immature follicles long-tuberculate, densely hirsute

Type in the U. S. National Herbarium, no. 1,251,722, collected in wet forest on Barro Colorado Island in Gatún Lake, Canal Zone, Panama, November, 1925, by Paul C. Standley (no. 40946). Nos. 40871 and 41116, from the same locality, represent the same species

In this large genus, whose species are so badly in need of critical revision, it is difficult to suggest the relationship of the plant here described. It has not been possible to refer it to any of the few species reported previously from Central America.

The extremely fine and dense pubescence of the leaves makes them feel soft and greasy to the touch.

Vincetoxicum edule (Hemsl.) Standl.

Gonolobus edulis Hemsl Biol Centr. Amer. Bot 2: 331. 1882.

Vincetoxicum pseudobarbatum (Pittier) Standl.

Gonolobus pseudobarbatus Pittier, Contr. U S Nat Herb. 13: 105. *f. 14.* 1910.

Vincetoxicum dubium (Pittier) Standl.

Gonolobus dubius Pittier, Contr. U. S. Nat. Herb. 13: 106. *f. 15.* 1910.

Vincetoxicum viridiflorum (Mey.) Standl

Cynanchum viridiflorum Mey Prim Fl. Esseq. 141. 1818.
Gonolobus viridiflorus Roem & Schult Syst. Veg. 6: 61. 1820.

Lycianthes Maxonii Standl., sp nov.

Slender branched erect shrub 1–3 meters high, branchlets at first minutely pilose with incurved lustrous hairs, later subterete, glabrous; leaves solitary, subequal, the petioles 4–6 mm long, leaf blades oblong-obovate to cuneate-obovate, 9–13 cm. long, 3–5 cm wide, abruptly short- or long-acuminate (acumen short and obtuse or 15 mm long and attenuate), cuneate or obtuse at base, thin, at first minutely punctulate, in age glabrous, above deep green, paler beneath; inflorescences sessile in the leaf axils, 1 to 3-flowered, the pedicels slender, 6–22 mm long, glabrous, divaricate or recurved, calyx cup-shaped, 2.5 mm long, 3 mm broad, glabrous, whitish, bearing near the truncate subscarious margin (about 1 mm below the margin) 5 very short, wartlike, greenish tubercles; corolla violet, stelliform, 5 mm. long, glabrous outside, deeply lobed, the lobes linear-oblong, acute; filaments equal, 1.5 mm. long, glabrous, the anthers oblong, 3.5 mm. long, connate, obtuse, dehiscent by minute apical pores; fruit subglobose, bright red, about 1 cm. in diameter, 4-seeded

Type in the U. S. National Herbarium, no. 1,180,543, collected in wet forest on Barro Colorado Island in Gatún Lake, Canal Zone, Panama, June 6, 1923, by William R Maxon (no. 6808).

The following additional collections from Barro Colorado Island belong here: *Standley* 31365, 31326, 40880, 41088, 41145.

Lycianthes Maxonii is related, apparently, to the Guatemalan *L. ceratocalycia* (Donn. Smith) Bitter, which has a calyx with usually 10 appendages, and a corolla 15 mm. long.

Lycianthes Maxonii var. **appendiculata** Standl., var. nov

Like the typical form in habit and foliage, pedicels solitary, calyx furnished with 5 filiform divaricate teeth about 1.5 mm. long, inserted well below the truncate margin

Type in the U. S National Herbarium, no. 1,217,917, collected in moist forest along the Río Tapia, Province of Panama, Panama, by Paul C. Standley (no. 28040).

In the long spreading calyx appendages this plant is strikingly different from the typical form, but since there are no other distinguishing characters, it is probably only a variant of the plant found on Barro Colorado Island.

Lycianthes solitaria (Blake) Standl

Solanum solitarium Blake, Contr U S Nat Herb. 24: 21 1922.

Solanum calochromum Blake, published on the same page, is a synonym of *Lycianthes nitida* Bitter, both names being based in part on the same collections.

Solanum hirsutissimum Standl, sp nov

Plant herbaceous or suffrutescent, sparsely branched, about 1 meter high, the branchlets stout, densely pilose with soft divaricate several-celled hairs 4–5 mm long, densely prickly, the prickles stout, laterally compressed, divaricate or recurved, minutely glandular, 5–10 mm. long, at base 2 5-6 mm. broad; leaves solitary, the petioles 2 5–5 cm. long, pilose and prickly like the stems; leaf blades broadly ovate or rounded-elliptic, 13-19 cm. long, 9–16 cm. wide, acute or obtuse, at base truncate or subcordate, shallowly lobed, the lobes about 5 on each side, broadly triangular, acute or obtuse, up to 2.5 cm. long, leaves densely pilose on both surfaces, armed on the nerves with long straight prickles, the hairs of the upper surface long, simple, those of the lower surface sessile or short-stipitate, multiradiate at apex, the rays elongate, several-celled, simple hairs often mixed with the stellate ones, pedicels pseudolateral, solitary or geminate, slender, 1 5–2 cm long, densely pilose, unarmed, recurved in fruit, calyx campanulate, 5-lobed to the middle, outside densely pilose with slender simple glandular hairs, 17 mm. long, about 20 mm. broad, thin, the lobes broadly ovate, obtuse or acutish; corolla 2 cm long, densely glandular-pilose outside, stamens equal, the anthers subsessile, connivent, 11 mm long, 2 mm. wide, dehiscent by apical pores; ovary densely hirsute; fruit globose, orange-colored, about 3 cm in diameter, smooth, sparsely hirsute, the hairs long, bearing at the base numerous very short rays; seeds numerous, compressed, 2.5 mm wide, scrobiculate.

Type in the U. S National Herbarium, no. 715419, collected along the Río Dupí, eastern Chiriquí, Panama, near sea level, Dec. 19, 1911, by H. Pittier (no 5217). The following collections also belong here:

PANAMA: Río Tapia, Province of Panama, *Standley* 30659, 28293, 26157.

This plant is weedy in habit and ordinary in appearance, and should be referable to some earlier described species, but I have been unable to find any description or named specimens with which it agrees.

Solanum allophyllum (Miers) Standl.

Pionandra allophylla Miers in Seem. Bot. Voy. Herald 174. 1854.
Cyphomandra allophylla Hemsl. Biol. Centr. Amer. Bot. 2: 417. 1882.
Solanum ellipsoideibaccatum Bitter, Repert. Sp. Nov. Fedde 11: 486. 1913.

The specific name is too much like *S. alloiophyllum* Dammer, but since the two are derived from different Greek words, both may be maintained in the genus.

[Capsicum macrophyllum (H. B. K.) Standl.

Witheringia macrophylla H. B. K. Nov. Gen. & Sp. 3: 14. 1818.
Bassovia macrophylla Coulter, Bot. Gaz. 16: 145. 1891.

Parmentiera Valerii Standl., sp. nov.

Tree about 12 meters high, the trunk 40 cm. in diameter, the crown narrow, sparsely branched, the branchlets ochraceous, glabrous, furnished with numerous pale lenticels; leaves subopposite, often fascicled at the nodes, the petioles slender, glabrous, 4–7 mm. long; leaflets 4–7, usually 5, slender-petiolulate, elliptic to obovate, 2.5–5 cm. long, acute, at base attenuate or cuneate, entire, glabrous, blackish when dried; flowers and fruits borne on the lower part of the trunk, fasciculate, the pedicels 2–2.5 cm. long; calyx green, spathaceous, cleft on one side to the base, rounded at apex, glabrous, 3.2–4 cm. long; corolla white, 6–7.5 cm. long, glabrous, funnelform, the tube 6–7 mm. thick, 2–3 cm. wide in the throat, the lobes short, undulate; immature fruit about 20 cm. long and 4 cm. thick, green, smooth, seeds oval, compressed, about 6 mm. long.

Type in the U. S. National Herbarium, no. 1,251,451, collected in wet forest near Naranjos Agrios, Guanacaste, Costa Rica, altitude 700 meters, Jan. 29, 1926, by Paul C. Standley and Juvenal Valerio (no. 46411).

Only one tree of this species was seen in the Cordillera of Tilarán. This was too large to be climbed, and it was only by throwing sticks at the high crown that imperfect specimens of the leaves could be obtained. The leaves seemed very immature, and when fully grown they probably exceed considerably the dimensions indicated in the description.

The two other species of *Parmentiera* known from Central America have uniformly three leaflets and winged petioles.

ZOOLOGY.—*Rhigonema (Isacis* Scrjabin, 1914; *?Isacis* Baylis & Daubney, 1926; nec *Isacis* Lespés, 1856), *nemas inhabiting the intestine of millipeds.*[1]

J. R. CHRISTIE and N. A. COBB, Bureau of Plant Industry.

The first rhigonema adequately described was *Ascaris infecta* Leidy, 1849, from North America,—redescribed and figured in "A Flora and Fauna within Living Animals," Smithsonian Contributions to Knowledge, Washington, 1853; a second was *Rhabditis acuminata* D'Udekem, 1859, from Europe; a third, the type species, *Rhigonema brevicolle* Cobb, 1898, from Australia; a fourth, *Isacis multipapillata* Scrjabin, 1914, from British East Africa. These rhigonemas constitute a very distinct and easily recognized homogeneous generic group.

ISACIS

The rhigonemas have been wrongly referred to *Isacis*, Lespés, 1856.[2] We consider it impossible, from the literature or in any other way, satisfactorily to determine the nema from the investigation of which Lespés proposed his insufficiently characterized genus *Isacis*, and therefore think the name *Isacis* should be abandoned. The various efforts to rehabilitate it have resulted only in additional uncertainty and confusion. Of the well founded nemic genera, established, some of them before the date of Lespés' article, some of them later, there are several to which Lespés' nema might conceivably be assigned, but always with so much uncertainty as to make such a course wholly impracticable,—e.g. *Diplogaster*, *Rhabditis*, *Anguillula*, one or more of the *Oxyuridae*, and several others. Lespés said his specimens closely resembled *Leptodera* Dujardin; were three-lipped, oviparous, and with the vulva near the middle of the body. He declared the male sexual armature identical with that of *Leptodera*, except that there was no bursa. Lespés gave no clear indication that his specimens possessed a pharynx;—we presume his word "bouche" should be translated, "mouth," and not "pharynx" or "throat." His "three tubercles" we take to be the three lips he later mentioned, faintly shown also in his illustrations. The illustrations show the presence of two equal spicula, but whether joined distally, as in some rhabdites, is left uncertain. He clearly figured the accessory piece,—

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[1] Received Nov. 27, 1926

[2] Ann Sci. Nat. IV. Zool. 5-6: 335 1856

in fact, of all the characters he listed, the nature of the accessory piece was one of the most clear and unmistakable.

Nevertheless the characters he gave do not adequately define either a species or a genus.

ISACIS AND RHIGONEMA

While the features described by Lespés are inadequate for the characterization of either a species or a genus, they are ample, in our opinion, to exclude from *Rhigonema* any species having them. Yet Scrjabin carefully described a *Rhigonema*, his *R. multipapillata*, and referred it to *Isacis* Lespés; (perhaps following Diesing,—a course we are unable to understand, for it is very manifest that Diesing's "*Isacis* Lespés" designates a practically meaningless collection of either unrecognizable or incompatible forms). The same course has been followed by Baylis and Daubney, whose text seems to indicate that they used Scrjabin's description as a main source for the characterization of *their Isacis* Lespés.

RHIGONEMA, COBB, 1898.

Cylindroid nemas having the following average size and form.

$$\frac{0.6}{2.7}\ \frac{4.0}{3.6}\ \frac{8.3}{4.}\ {}^{27\cdot 54\cdot 19}\ \frac{92.}{5.\ [illegible]\ 2.[illegible]}\ 6.3\text{mm}\qquad \frac{0.8}{2.8}\ \frac{4.5}{3.7}\ \frac{9.5}{4.5}\ \frac{94\cdot[illegible]}{4.5}\ \frac{92.}{2.8}\ 4.8\text{mm}$$

with a more or less acute conoid posterior extremity; cuticle colorless, exceedingly finely striated, faintly winged if at all, sometimes with exceedingly minute retrorse prickles, especially anteriorly; lateral chords one-sixth to one-third as wide as the body; musculature oxyuroid,—e.g. in *R. infectum*, 16 equivalent fields, 4 in each quadrant; anteriorly subtruncate with three very flat, thin, mobile lips overlying an exceedingly shallow vestibule, leading to a small but definite triquetrous pharynx, this latter armed in front with three broad, inwardly arcuate, lobed and denticulate, more or less retrorse onchia joined into a transverse triangle, at the blunt corners of which they are so "hinged" together as to be worked by antagonistic muscles. (1) very weak "extensors" passing from the onchia radially outward and very slightly forward, the muscles doubtless aided by the elasticity of the labial region; (2) powerful retractors passing from the onchia backward and outward. Cephalic papillae, four, submedian, small;

circular depressed amphidial openings small, but larger than the papillae, and arranged in practically the same circlet with them near the margin of the head. Oesophagus unusually broad and strong, with a more or less indistinct pharyngeal swelling but very distinct, broad, even napiform, highly muscular cardiac bulb, set off, fore and aft, by distinct constrictions and armed with a large triple corrugated valve. A circlet of nine (3 double, also 3 single, opposite the onchia and alternating with the 3 double) saccate, cephalic, often pigmented glands empty into the pharynx. Large cardia flat, three-lipped. The faintly tessellated intestine is set off by a distinct constriction. Renette bilateral. Anterior lip of the vulva usually more or less papilliform and slightly retrorse. ‘ ♀ ’, the details as figured by Leidy, except that the pear-shaped swelling between each ovary and uterus should be regarded as a spermatheca. In young but mature females elongated cephalated sperms may occur in the unpaired enlargement sometimes present near the vulva. The numerous ellipsoidal, smooth eggs are deposited after segmentation has begun Males with two equal spicula without accessory piece. ‘♂. No bursa. There is a single pre-anal ventral papilla in addition to the small pre- and post-anal "submedian" ones. Type species, *R. brevicolle*

Habitat: Parasitic in the intestine of millipeds

Julus and *Spirobolus*, both hosts of rhigonemas, represent groups of millipeds consisting of numerous species found in many different parts of the world. This fact, together with the morphology and distribution of the known rhigonemas, warrants the prediction that species of *Rhigonema* will prove numerous. Parona's *Isacis modiglianii*, 1896, may perhaps prove to be a rhigonema.

As the millipeds have come down to us from as long ago as the carboniferous era with relatively little morphological, and therefore presumably little physiological, change, their parasites are of unusual interest. Should the latter also have meanwhile evolved similarly, it is not unreasonable to expect from this source hints as to the primitive form of some nemic structures.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

940TH MEETING

The 940th meeting was held in the auditorium of the Cosmos Club on Saturday evening, May 15, 1926. The meeting was called to order by President **Bowie** at 8:17, with 55 persons in attendance.

The program for the evening consisted of an address by Dr. **John C. Merrian** on *The Meaning of Evolution in Individnal Experience.* Discussed by Messrs. **Hawkesworth**, **C. A Briggs**, **Crittenden**, **Wright**, **Bowie**, **Tuckerman**, **Marmer**, **Thone** and others.

941ST MEETING

The 941st meeting was held jointly with the Washington Academy of Sciences and the Chemical Society on Saturday evening, May 29, 1926, in the Auditorium of the Cosmos Club The meeting was called to order by President **Burgess** of the Academy at 8:16 P.M. with 144 persons in attendance.

The program for the evening consisted of an address by Professor **Ernst Cohen** of the University of Utrecht, on the subject: *Metamorphosis of matter and the alleged constancy of our physico-chemical constants.* The address was illustrated with lantern slides and with experiments Discussed by Messrs. **Washburn**, **Norris**, **Hudson**, **Heyl**, **Sosman**, **Lind**, **Wright**, and **White**.

942D MEETING

The 942d meeting, the first meeting following the summer intermission, was held at the Cosmos Club on Saturday evening, October 2, 1926. The meeting was called to order by President **Bowie** at 8:16 P.M. with 52 persons in attendance.

The program for the evening consisted of an address by Dr. **H. U. Sverdrup** Director of the Geophysical Institute B of Bergen, on *The tides on the north Siberian shelf; their bearing on the existence of land in the Arctic Sea, and their dynamics* (Illustrated with lantern slides).

The address was published in This Journal for Dec. 3, 1926.

The subject was discussed by Messrs. **Breit** and **Marmer** On behalf of the Society President **Bowie** thanked the speaker for his interesting address.

Upon call for informal communications Mr. **W D Lambert** called attention to the work of Esclangon on the hypothesis of a cosmic tide due to the translation of the solar system through space This was discussed by Messrs. **Breit** and **Woolard**. Mr. **Hawkesworth** then spoke on a mathematical development of the law of disintegration of radium.

943D MEETING

The 943d meeting was held at the Cosmos Club on Saturday evening, October 16, 1926. The meeting was called to order by Vice-President **Ault** at 8:17 P.M with 65 persons in attendance.

The program for the evening consisted of an address by Dr. **C. G. Abbot**, on *A new observatory in Southwest Africa.* (Illustrated with lantern slides.) The speaker described the present state of the investigation of the Smithsonian Institution on the variation of the sun. For fifteen years, measurements were carried on by the method of Langley at Mount Wilson, California, from 1905 to 1920. Beginning with July, 1918, daily observations, as far as possible, have been continued at Calama, Chile, and at Mount Montezuma, Chile, up to the present time. Starting with October, 1920, observations were continued at Mount Harqua Hala, Arizona, until October, 1925, when the station was removed to Table Mountain, California, where the daily observations are still going on

A comparison of the daily values at Mount Montezuma and Mount Harqua Hala indicates an average daily divergence of about ½ per cent. A considerable number of days failed of observations at both stations, and a large number failed of record at one station or the other. Hence it appeared that the satisfactory study of the variation of the sun requires at least one, and preferably two additional stations, to be located in the most cloudless and favorable high-altitude regions to be found in the world.

The National Geographic Society, appreciating this need, and the worldwide bearing of the observations of the sun's radiation, made a grant to Dr. ABBOT in the year 1925 to enable him to select the best available station in the eastern hemisphere, equip an observatory, and carry it on for approximately four years

The speaker described the conditions desirable and the evidence which pointed to Algeria, Baluchistan and Southwest Africa as the most promising countries for the location. He described the investigations which were made in these countries, which resulted in the selection of Mount Brukkaros in Southwest Africa of which the altitude is 5,202 feet, the longitude, 17° 48′ E and the latitude 25° 52′ S As this station is situated in the central part of the Hottentot Reservation it was necessary to obtain permission of the Hottentots to locate there. The road, garage, reservoirs, observing tunnels and dwelling house were prepared during the summer of 1926, under the direction of Mr A Dryden, Inspector of Public Works for the Government of Southwest Africa

An expedition under Mr. W H Hoover, field director, with Mr. F A Greeley, assistant, provided with sixty cases of apparatus and accessories, landed at Cape Town on September 13, 1926, and it was expected that actual observations on Mount Brukkaros would be undertaken by the end of October.

The average rainfall in the region is 3½ inches It occurs mainly in the months of February and March, so that the months of December and January which are the least satisfactory at the stations on Table Mountain and Montezuma will be very good months at Mount Brukkaros The speaker was at or near Mount Brukkaros for twelve days in early March, which is the height of the rainy season, and during his stay eleven days of the twelve would have been satisfactory for the solar radiation observations.

Doubt having been expressed by various critics as to the reality of the variation of the sun, and as to the reality of the influence which, according to Clayton, solar variation reflects on the weather, the speaker exhibited a number of slides confirming these supposed effects Numerous slides illustrative of the journey of explorations and the stations engaged in solar radiation work were shown (*Author's abstract.*)

The address was discussed by Dr BREIT.

944TH MEETING

The 944th meeting was held at the Cosmos Club on Saturday evening, October 30, 1926 The meeting was called to order by President BOWIE at 8:17 with 36 persons in attendance

The program for the evening consisted of two papers. The first by W. P White was on *Improvements in galvanometer stabilizers.* Apparatus, particularly galvanometers, can be shielded from horizontal disturbances by hanging with wires or cords. Julius (1895), who used three wires, showed that the suspended body is apt to perform vibrations about a horizontal axis through its own center of gravity. He tried to avoid these by attaching his wires at the same level as the center of gravity and subsequently arranged to place the galvanometer so that its head came at the point of least motion, that is, at the center of gravity. This produced a relatively complicated and expensive apparatus. He put his dampers also at the level of the center of gravity. These dampers were crossed vanes of sheet metal attached to the stabilizer and immersed in pots of heavy oil

In some cases it has been found that these secondary rotational oscillations are negligible When this is the case the construction can be much simplified A suggestion coming from the Reichsanstalt is that the damper should be put below. This is both easier and more convenient and tends to damp the secondary oscillations, which Julius' arrangement damps as little as possible

With swing coil galvanometers exceedingly slight changes of level produce large deflections, and it seems probable that an instrument suspended from three long, slender wires would be tipped through differential expansion if the room temperature is not especially uniform and constant This difficulty is almost entirely avoided if the instrument is suspended from two wires which hang from two opposite arms of a horizontal cross whose two other arms are supported from above and which is free to shift its position slightly in case the wires expand differently.

Heavy oil is an admirable damper. An instrument floating in the center of a moderately large tank of it—one containing perhaps from twenty to forty dollars worth of oil—would probably be stabilized for almost any conceivable conditions. Damping is almost indispensable with suspended bodies (oil damping is generally used), but the damper transmits some motions while it quenches others. If the vessel of oil is relatively wide impulses coming from its walls, that is, from the building, are largely damped by the oil itself before they reach the suspended apparatus. Damping alone, however, will not insure complete absence of vibration because the damper has no action until some motion is present.

Since the vibrations of apparatus, especially of suspended apparatus, are largely influenced by resonance, general conclusions can not be drawn from the performance in a few instances. (*Author's abstract.*)

The paper was discussed by Messrs. Bowie, McKeehan, Tuckerman and Humphreys.

The second paper of the program was by G. R. Wait on *The magnetic permeability of iron and magnetite in high-frequency alternating fields.* (Illustrated with lantern slides). Arkadiew measured the absorption of electric waves by two parallel wires, and found that the permeability of iron and nickel wires varied with the wave-length The values for both iron and nickel decreased to very small values when the wave-length was decreased to 1 3 cm. He explained this decrease in the ferro-magnetic property in iron and nickel on the basis of the natural vibrations of the elementary magnets. From these results, together with those of other workers, particularly those of Kartschagin and those of Wwedensky and Theodortschik, the conclusion was drawn that the elementary magnets had several periods of oscillation. In view of the attention this subject has received and must continue to receive in the field of magnetism, the author undertook a repetition of the work of Wwedensky and Theodortschik.

Two experimental methods have been followed, the one making use of a high-frequency oscillating tube circuit and a resonating circuit, the other employing two high-frequency tube circuits and one audio-frequency circuit. The former is known as the resonance method and the other as the heterodyne beat method.

Various forms of iron, such as filings, wires, and powder, were used as well as magnetite in the form of crystals and powder. The resonance method extended from about 50 to 160 meters wave-length, while the heterodyne beat method covered the range from about 80 to 1,700 meters

Wwedensky and Theodortschik found an abnormal increase in the permeability of iron wires at about 100 meters which was attributed by them to the resonance of the elementary magnets. The present investigation failed to confirm this result. Although apparent anomalies at first were found, it was discovered that they were all due to resonance between various parts of the circuit Upon eliminating this difficulty no abnormal change in permeability over the range covered was found. Consequently, the author feels justified in concluding that if elementary oscillators exist, they have failed to resonate at the frequencies employed.

Various errors in the work of Wwedensky and Theodortschik were pointed out. Some of these may have been largely responsible in producing the apparent anomalies observed by them (*Author's abstract*)

The subject was discussed by Messrs BAUER, McKEEHAN, SOSMAN and BREIT The complete paper will be published in an early number of the *Physical Review.*

Upon invitation of the President, Dr. BAUER explained informally the status of the International Research Council and affiliated Unions

H. A MARMER, *Recording Secretary.*

GEOLOGICAL SOCIETY

406TH MEETING

The 406th meeting was held in the Cosmos Club May 6, 1925.

Program· T. A JAGGER: *Engulfment in volcanism* The speaker called attention to the published result of measurement of volume of rock engulfed[1] in the explosive eruptions at Kilauea in May, 1924 Engulfment accounted for 253 times the amount ejected explosively. This observation was made by Mr. R H Finch at the Observatory. The engulfed rim rock equalled over seven billion cubic feet, equivalent to a cylindrical column reaching down 3,000 feet below the bottom of the remnant pit, and having the diameter of that bottom This breccia must partially choke the vent to great depths. The explosions appeared to be actuated by steam, rising through orifices in the jumble of fallen crags, ejecting nothing but old and mostly crystalline rocks, and vented by different parts of the bottom area. The explosion phenomena followed three months of down-faulting and crateral subsidence, and accompanied acceleration of engulfment already initiated. Engulfment phenomena in great volume have been common in the past without any explosion. The sequence of phenomena from 1914 to 1924 agrees with the hypothesis that tension of magma opened fault rifts in the larger edifice, lava in the pit shaft lowered hydrostatically, the pit walls collapsed into the rift when deprived of the magmatic pressure, ground water entered the shaft between hot lava below and a plugged vent above, and a geyser mechanism resulted. Thereafter the gas tension in the magma reasserted itself, the lava rose and shut off the ground water, and in July the lava reappeared for a fortnight in the bottom of the pit

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[1] Bull. Haw Volc Obs , December, 1924

Dr. E. S. SHEPHERD suggests that the enormous amount of weathered rock engulfed would feed oxygen in the form of ferric iron oxide to new attack by hydrogen, so that a large amount of heat would be liberated, and the ferric iron would be reduced to ferrous. The abundant surfaces of the breccia would make diffusion possible in a rising magma charged with hydrogen, resulting in oxidation of the hydrogen thoroughly but not too rapidly, and in oxidized gas at the surface of the lava lakes This is what we find. An excess of ferric over ferrous oxide in the engulfed material of only one percent more than in the glass would raise the temperature of one tenth of the breccia from 20°C. to 1200°C yielding heat enough to keep the volcano going for years (*Author's Abstract*)

J. D. SEARS, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

The Smithsonian Institution has received recently the botanical library which was presented to the Institution several years ago by Captain John Donnell Smith, of Baltimore This is one of the finest private botanical libraries of the United States, and is especially rich in works relating to the flora of tropical America.

Mr. ELLSWORTH P KILLIP and Mr ALBERT C. SMITH, of the National Museum, who are engaged in botanical exploration in Colombia, have had headquarters for several weeks at Cartagena. This port is of interest because it is the type locality of many species described by Jacquin over 150 years ago A visit has been made also to Turbaco, where Humboldt collected the types of many plant species

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SPECTROSCOPY.- *Regularities in the arc spectrum of lanthanum.*[1]

W. F. Meggers, Bureau of Standards.

Although regularities among lines of the spark spectrum of lanthanum (La II) have been known for some time,[2] nothing concerning the structure of the arc spectrum of this element (La I) has heretofore been published. With the aid of new data, the analysis of the La II spectrum has recently been extended,[3] and the first regularities in the La I spectrum were detected. The new descriptive material included an extensive list of temperature classifications of lanthanum lines by Dr. King and Miss Carter,[4] and some unpublished Zeeman-effects observed by the late Professor B. E. Moore. The temperature classification has been especially valuable on account of its division of the La lines into two sets, one set (La I) characterizing the neutral atom and the other (La II) the ionized atom of lanthanum. The multiplets in either spectrum have a large wave length range so that estimation of line intensities becomes very difficult and there is furthermore a possibility that certain deviations from the intensity rules might be expected for heavy atoms like La. Nevertheless, the estimates of line intensities by King and Carter have been very useful in the construction of multiplets and it appears that the intensity rules are usually fulfilled, at least qualitatively. In a similar manner deviations from the Landé g values might be expected to produce some strange Zeeman-effects for La I lines since such have already

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[1] Published by permission of the Director of the Bureau of Standards Received December 9, 1926

[2] Popow, Ann der Physik, **45**: 147 1914
Paulson, Ann. der Physik, **45**: 1203. 1914
Goudsmit, Kon Akad Wet. Amsterdam, **33**: No 8 1924

[3] Meggers, J O. S A. & R S I In press.

[4] King and Carter, Astrophys. Journ In press

TABLE 1.—Relative Terms in the La I Spectrum

Term symbol	Term value	Level separation	Combinations
a^2D_2	00 0		a^2P, b^2P, $a^2\overline{D}$, $b^2\overline{D}$, $c^2\overline{D}$, $d^2\overline{D}$, a^2F, b^2F, c^2F, d^2F, e^2F, I, II, III, IV, $a^4\overline{D}$, a^4F, b^4F, $a^4\overline{G}$
		1053 2	
a^2D_3	1053 2		
$a^4\overline{F}_2$	2668 2		a^2P, $a^2\overline{D}$, $b^2\overline{D}$, $c^2\overline{D}$, a^2F, b^2F, c^2F, $a^4\overline{D}$, a^4F, b^4F, $a^4\overline{G}$
		341 8	
$a^4\overline{F}_3$	3010 0		
		484 6	
$a^4\overline{F}_4$	3494 6		
		627 0	
$a^4\overline{F}_5$	4121 6		
I	14804 1		a^2D, $a^4\overline{F}$
$a^2\overline{D}_2$	15031 7		a^2D, $a^4\overline{F}$
		1506 7	
II	15196 8		a^2D, $a^4\overline{F}$
$a^2\overline{D}_3$	16538 4		
a^2F_3	16856 9		a^2D, $a^4\overline{F}$
		1053 3	
$b^2\overline{D}_2$?	17699 8		a^2D, $a^4\overline{F}$
a^2F_4	17910 2		
		247 3	
$b^2\overline{D}_3$	17947 1		
$a^4\overline{G}_3$	18156 9		a^2D, $a^4\overline{F}$
$c^2\overline{D}_2$	18172 3		a^2D, $a^4\overline{F}$
		447 0	
		1207 1	
$a^4\overline{G}_4$	18603 9		
		525 4	
$a^4\overline{G}_5$	19129 3		
$c^2\overline{D}_3$	19379 4		
a^2P_2	20019 1		a^2D, $a^4\overline{F}$
		988 1	
a^4F_2	20083 0		a^2D, $a^4\overline{F}$
		178 3	
$a^4\overline{G}_6$	20117 4		
		255 2	
a^2P_1	20197 4		
a^4F_3	20338 2		
		425 0	
a^4F_4	20763 2		
		620 8	
b^2F_3	20972 1		a^2D, $a^4\overline{F}$
a^4F_5	21384 0		
		475 8	
b^2F_4	21447 9		
c^2F_4?	21662 5		a^2D, $a^4\overline{F}$

TERM SYMBOL	TERM VALUE	LEVEL SEPARATION	COMBINATIONS
$a^4\overline{D}_1$	22246 6		a^2D, $a^4\overline{F}$
		192 8	
$a^4\overline{D}_2$	22439 4		
		364.9	
$a^4\overline{D}_3$	22804 3		
		498 9	
$a^4\overline{D}_4$	23303 2		
d^2F_3	23875 0		a^2D, $a^4\overline{F}$
		534 7	
d^2F_4	24400 7		
b^4F_2	24507 8		a^2D
		476 5	
b^4F_3	24984 3		
c^2F_4?	25218 1		a^2D
		306 0	
b^4F_4	25380 3	424 0	
e^2F_3?	25643 0	616 7	
b^4F_5	25997 0		
III	27022 7		a^2D, $a^4\overline{F}$
b^2P_1?	27968 7		a^2D
		253 7	
b^2P_2?	28722 4		
d^2D_3?	29502 3		a^2D
		62 7	
d^2D_2?	20565 0		
IV	30788 5		a^2D
V	30807 0		a^2D

been noted[5] for La II lines. Even though the available Zeeman-effect data for La I lines are not very precise, they nevertheless serve to identify most of the important levels in the doublet- and quartet-systems of spectral terms.

The relative terms, comprising 48 levels in the La I spectrum are presented in Table 1 in which the successive columns contain (1) the term symbol for each level, (2) the relative energy value on the basis of $a^2D_2 = 0.0$, (3) the level separations of the complex terms,' and (4) a summary of the term combinations. Until better criteria are available the spectroscopic symbols suggested for several of the levels must remain in doubt; five of the levels are tentatively represented by Roman numerals.

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[5] GOUDSMIT, Kon Akad Wet Amsterdam, 33: No 8. 1924

As in scandium[6] and yttrium,[7] likewise in lanthanum the lowest energy (normal state) of the atom is represented by a doublet-D, and the first metastable state by a quartet-F term. According to the theory of Heisenberg and Hund[8] the former results from the ds^2 configuration of 3 electrons, and the latter from d^2s; the first triad of quartet terms (^4D, ^4F, ^4G) arising from the d^2p arrangement.

It is of interest to compare the interval ratios of the metastable quartet-F term with the theoretical values, since in yttrium a most remarkable agreement was found[9] for the analogous term. The interval rule is indeed obeyed by this term almost equally well in all three spectra (Sc I, Yt I, La I), as can be seen from the following:

	Separations			Ratios		
Theoretical	$^4F_5-^4F_4$	$^4F_4-^4F_3$	$^4F_3-^4F_2$	= 9.00	: 7.00	: 5.00
21 Sc	66.9	52.5	37.8	= 9.00	: 7.06	: 5.08
39 Yt	254.1	199.4	141.3	= 9.00	: 7.06	: 5.00
57 La	627.0	484.6	341.8	= 9.00	: 6.95	: 4.90

If this is not a coincidence it indicates that small, progressive changes in the interval ratios occur for analogous terms in spectra of elements in successive periods.

The combinations of terms in Table 1 are given in detail in Table 2, beginning with combinations of doublet with doublet terms. These are followed in order by doublet-quartet, quartet-quartet, and quartet-doublet combinations. The symbols and term values of the low levels are placed at the head of the table, and the data for the higher levels at the left margin. The differences of the combining term values are represented in the body of the table by the vacuum wave numbers of the spectral lines. Wave length data are printed immediately above the wave numbers, and are followed by parentheses containing intensity estimates and temperature classes as given by King and Carter. The wave lengths shorter than 5500A are from the measurements of Wolff[10] and the longer ones are by Kiess;[11] the former being converted from Rowland's scale to the International Angstrom scale of wave lengths in which the latter were measured.

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[6] Meggers, This Journal 14: 419. 1924.

[7] Meggers, This Journal 14: 419. 1924.
Meggers and Moore, This Journal 15: 207. 1925.
Meggers and Kiess, J. O. S. A. & R. S. I., 12: 417. 1926.

[8] Heisenberg, Zeitschr. f. Phys. 32: 841. 1925.
Hund, Zeitschr. f. Phys. 33: 345. 1925.

[9] Meggers and Moore, This Journal 15: 207. 1925.

[10] Wolff, Zeitschr. f. wiss. Phot. 3: 395. 1905.

[11] Kiess, Sci. Pap. Bur. Stand. 17: 324. 1921.

TABLE 2 —COMBINATIONS IN THE La I SPECTRUM

	a^2D_3 1053 2	a^2D_2 00 0
V 30897 0	3349 81(3 III A) 29843 88	3235 64(5 III A) 30896 90
IV 30788 5	3362 03(12 III A) 29735 42	3247 03(8 II A) 30788 50
d^2D_3? 29502 3	3514 07(20 II A) 28448 93	3388 60(12 II A) 29502 27
d^2D_2? 29565 0	——— ? 28511 8	3381 42(15 II A) 29564 95
b^2P_2? 28722 4	3613 10(30 II) 27669 18	3480 61(8 III A) 28722 40
b^2P_1? 27968 7		3574 41(50 II) 27968 68
III 27022 7	——— ? 25969 7	3699 54(12 III A) 27022 87
e^2F_3? 25643 0	4065 58(30 II) 24589 80	3898 60(40 II) 25642 97
e^2F_4? 25218 1	4137 02(40 I) 24165 17	
d^2F_4 24409 7	4280 27(100 I) 23356 47	
d^2F_3 23875 0	4380 56(12 II A) 22821 74	4187 31(125 I) 23874 97
c^2F_4? 21662 5	4850 79(20 I) 20609 44	
b^2F_4 21447 9	4901 86(25 I) 20394 75	
b^2F_3 20972 1	- -—— ? 19918 9	4766 90(100 I) 20972 15
a^2P_2 20019 1	5271 19(150 I) 18965 78	4993 85(20 II) 20019 06
a^2P_1 20197 4		4949 76(200 I) 20197 36
c^2D_3 19379 4	5455 11(400 I) 18326 36	5158 69(80 I) 19379 38
c^2D_2 18172 3	5839 78(20 II A) 17119 19	5501 35(300 I) 18172 32
b^2D_3 17947 1	5917 62(15 II A) 16894 01	5570 38(5 II A) 17947 11
b^2D_2? 17699 8	——— ? 16646 6	5648 26(80 III) 17699 69
a^4F_4 17910 2	5930 60(400 I) 16857 05	

TABLE 2—*Continued*

	a^2D_3 1053.2	a^2D_2 00.0
a^2F_3 16856.9	6325.93(150 I) 15803.62	5930.60(400 I) 16857.06
a^2D_3 16538.4	6455.98(300 I) 15485.25	6044.85(2 III A) 16538.44
a^2D_2 15031.7	——— ? 13978.5	6650.80(100 I A) 15031.65
II 15196.8	7068.32(100 II) 14143.73	6578.52(400 I) 15196.81
I 14804.1	7270.08(5 II A) 13751.24	6753.04(50 I A) 14804.07
$a^4\overline{D}_4$ 23303.2	4493.14(25 I) 22249.93	
a^4D_3 22804.3	4596.18(10 I) 21751.12	——— ? 22804.3
$a^4\overline{D}_2$ 22439.4	——— ? 21386.2	4455.24(10 II A) 22439.12
$a^4\overline{D}_1$ 22246.0		4493.82(10 I A) 22246.57
a^4F_5 21384.0		
a^4F_4 20763.2	5072.13(1 III A) 19710.14	
a^4F_3 20338.2	5183.89(20 II) 19285.18	——— ? 20338.2
a^4F_2 20083.0	5253.46(100 I) 19029.80	4977.92(8 II A) 20083.11
b^4F_5 25007.0		
b^4F_4 25380.3	4109.49(15 II A) 24327.09	
b^4F_3 24984.3	4177.47(30 I) 23931.18	——— ? 24984.3
b^4F_2 24507.8	4262.35(15 II A) 23454.67	4079.18(40 I) 24507.87
$a^4\overline{G}_6$ 20117.4		
$a^4\overline{G}_5$ 19129.3		
$a^4\overline{G}_4$ 18603.9	5696.19(40 I) 17550.73	
$a^4\overline{G}_3$ 18156.9	5845.02(6 II A) 17103.85	5506.07(40 II) 18156.76

TABLE 2—*Continued*

	a$^4\overline{F}_5$ 4121 6	a$^4\overline{F}_4$ 3494 6	a$^4\overline{F}_3$ 3010 0	a$^4\overline{F}_2$ 2668 2
a$^4\overline{D}_4$ 23303 2	5211 87(300 II) 19181 65	5046 87(60 III) 19808 76	——— ? 20293 2	
a$^4\overline{D}_3$ 22804 3		5177 30(300 II) 19309 73	5050 56(80 II) 19794 26	4964 81(4 III A) 20136 16
a$^4\overline{D}_2$ 22439 4			5145 42(200 II) 19429 36	5056 46(80 II) 19771 20
a$^4\overline{D}_1$ 22246 6				5106 24(150 II) 19578 44
a^{4}F$_5$ 21384 0	5791 33(400 I) 17262 40	5588 35(80 II) 17889 42		
a^{4}F$_4$ 20763 2	6007 37(50 III A) 16641 63	5789 23(250 I) 17268 66	5631 22(100 I) 17753 24	
a^{4}F$_3$ 20338 2		5935 26(15 II A) 16843 80	5769 37(80 I) 17328 12	5657 74(50 II) 17670 00
a^{4}F$_2$ 20083 0			5855 58(15 II A) 17073 00	5740 65(100 I) 17414 82
b^{4}F$_5$ 25997 0	4570 14(250 I) 21875 06	4442 67(12 II) 22502 67		
b^{4}F$_4$ 25380 3	4702 63(10 I) 21258 77	4567 92(200 I) 21885 67	4468 98(25 II) 22370 22	
b^{4}F$_3$ 24984 3		4652 12(20 I) 21490 61	4549 51(50 I) 21974 24	4479 82(15 II A) 22316 08
b^{4}F$_2$ 24507 8			4650 35(15 I) 21497 75	——— ? 21839 6
a$^4\overline{G}_6$ 20117 4	6249 92(500 I) 15995 79			
a$^4\overline{G}_5$ 19129 3	6661 40(80 I A) 15007 71	6394 24(600 I) 15634 76		
a$^4\overline{G}_4$ 18603 9	6903 07(1 III A) 14482 31	6616 59(80 I) 15109 37	6410 98(300 I) 15593 93	
a$^4\overline{G}_3$ 18156 9		——— ? 14662 3	6600 17(50 II A) 15146 97	6454 51(200 I) 15488 77
III 27022 7			4163 30(8 III A) 24012 65	4104 88(60 I) 24354 43
e^{4}F$_3$? 25643 0		——— ? 22148 4	4417 11(6 III) 22632 80	——— ? 22974 8
e^{4}F$_4$? 25218 1	——— ? 21096 5	4602 04(20 III) 21723 42	4501 59(10 II A) 22208 15	
d^{4}F$_4$ 24409 7	——— ? 20288 1	4779 90(4 II) 20915 13	——— ? 21399 7	

TABLE 2—*Concluded*

	$a^4\overline{F}_5$ 4121 6	$a^4\overline{F}_4$ 3494 6	$a^4\overline{F}_3$ 3010 0	$a^4\overline{F}_2$ 2668 2
d^2F_3 23875 0		——— ? 20380 4	4791 38(5 II) 20864 98	4714 13(5 I) 21206 92
c^2F_4? 21662 5	5699 38(5 III) 17540 91	5502 66(10 III) 18168 01	5359 72(2 III A) 18652 52	
b^2F_4 21447 9	5769 99(25 III A) 17326 25	5568 48(50 II) 17953 25	5422 09(3 III A) 18437 96	
b^2F_3 20972 1		5720 03(10 III A) 17477 59	5565 74(20 II) 17962 10	——— ? 18303 9
a^2P_2 20019 1			5877 63(2 III A) 17008 96	5761 64(60 I) 17350 76
a^2P_1 20107 4				5703 29(10 III) 17528 90
c^2D_3 19379 4		6293 57(80 II A) 15884 85	6107 27(12 II A) 16369 43	5982 34(5 III A) 16711 26
c^2D_2 18172 3			6593 46(60 I) 15162 37	6448 15(60? II A) 15504 05
b^2D_3 17947 1		6917 24(10 III A) 14452 65	6692 88(30 I A) 14937 13	6543 15(500 I) 15278 95
b^2D_2 17699 8			——— ? 14689 8	6650 80(100 I A) 15031 65
a^2F_4 17910 2	——— ? 13788 6	6934 98(50 III) 14415 76	6700 50(200 I) 14900 14	
a^2F_3 16856 9		——— ? 13362 3	7210 88(15 II A) 13846 83	7045 93(300 II) 14188 67
a^2D_3 16538 4		7664 33(10? III) 13043 87	——— ? 13528 4	——— ? 13870 2
a^2D_2 15031 7			8316 03(2 IV A) 12021 67	8086 07(15 III) 12363 55
II 15196 8			8203 39(1) K 12186 73	7979 75(3n?) K 12528 30
I 14804 1		8839 67(1) K 11309 54	8476 48(2) K 11794 11	

Comparisons of the 3-electron spectra, Sc I, Yt I, La I, can best be drawn from energy diagrams, and for this purpose references will be made to Figures 1, 2, and 3, in which the various spectral terms are plotted as rectangles at distances from the zero axis proportional to their energies. The vertical height of each rectangle represents the range of the sub-levels in the term; the increase of these separations with atomic number is very noticeable. Each line connecting two spectral terms represents all the combination possibilities between the sub-levels of the combining terms, that is, a *multiplet* of spectral lines.

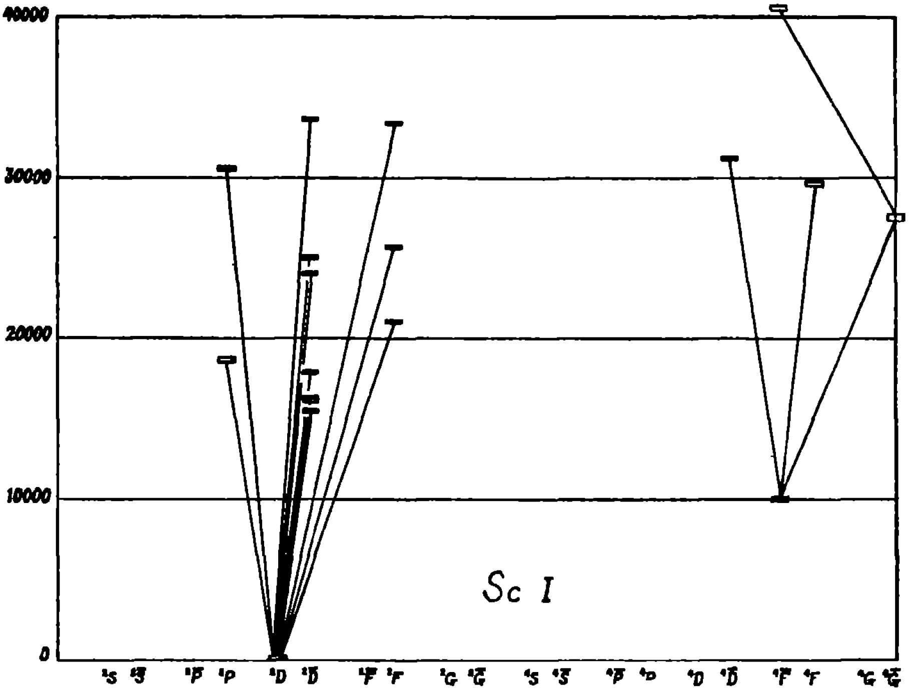
40000
30000
20000
10000
0
Sc I
^2S $^2\bar{S}$ $^2\bar{P}$ ^2P ^2D $^2\bar{D}$ $^2\bar{F}$ ^2F ^2G $^2\bar{G}$ ^4S $^4\bar{S}$ $^4\bar{P}$ ^4P ^4D $^4\bar{D}$ $^4\bar{F}$ ^4F ^4G $^4\bar{G}$

Fig. 1 —Energy diagram for the Sc I spectrum

Whereas in Yt I the quartet-F is about 11000 cm.$^{-1}$ above the doublet-D term, in La I it is only about 3000 units high. The value of quartet-F relative to doublet-D has not yet been established in Sc I, although the intersystem combinations have been sought for diligently. The reason is probably found in the weakness of these connecting lines. In the spark spectra of these three elements a remarkable increase of intensity of intersystem combinations was observed[3] as the atomic number increased. A similar state of affairs is now strikingly evident in the arc spectra; no intersystem connection has been detected in Sc I, the strongest one in Yt I has intensity 20, while in La I the strongest one is marked 500. In the absence of intersystem combinations for Sc I the low quartet-F term in Fig. 1

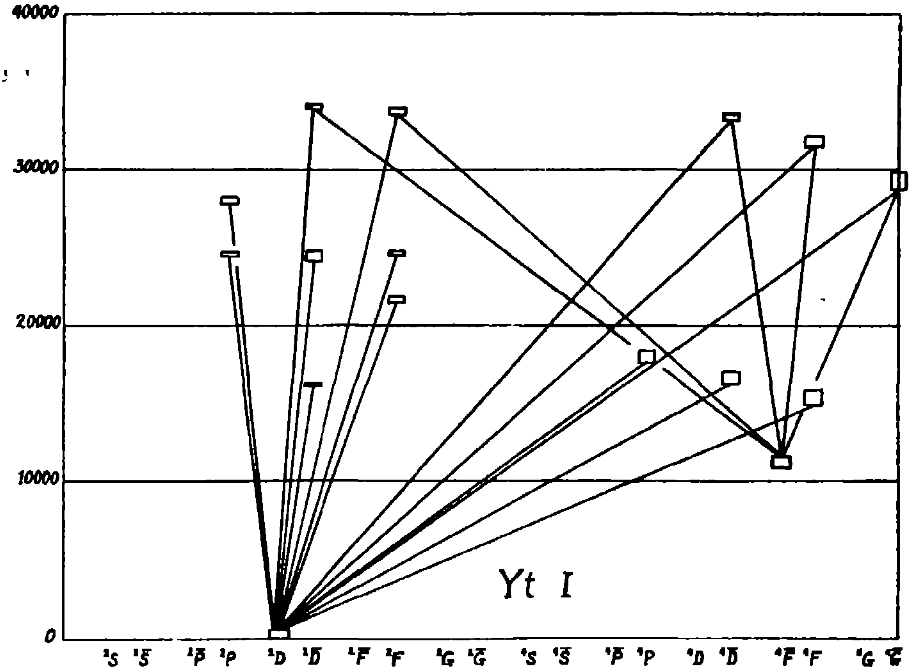
40000
30000
20000
10000
0
Yt I
^2S $^2\bar{S}$ $^2\bar{P}$ ^2P ^2D $^2\bar{D}$ $^2\bar{F}$ ^2F ^2G $^2\bar{G}$ ^4S $^4\bar{S}$ $^4\bar{P}$ ^4P ^4D $^4\bar{D}$ $^4\bar{F}$ ^4F ^4G $^4\bar{G}$

Fig 2.—Energy diagram for the Yt I spectrum

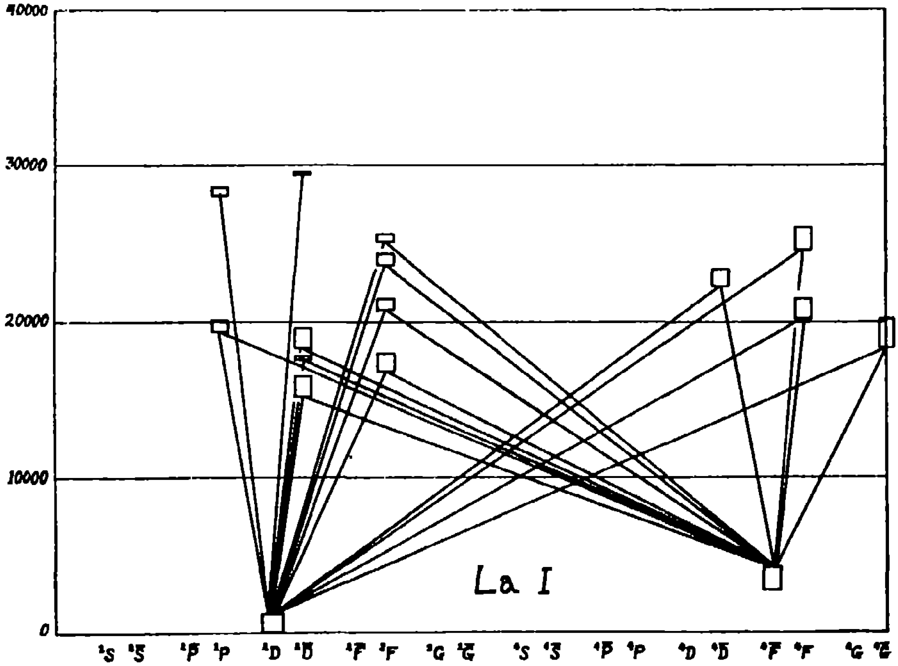
40000
30000
20000
10000
0
La I
^2S $^2\bar{S}$ $^2\bar{P}$ ^2P ^2D $^2\bar{D}$ $^2\bar{F}$ ^2F ^2G $^2\bar{G}$ ^4S $^4\bar{S}$ $^4\bar{P}$ ^4P ^4D $^4\bar{D}$ $^4\bar{F}$ ^4F ^4G $^4\bar{G}$

Fig. 3.—Energy diagram for the La I spectrum

is tentatively placed 10000 cm.$^{-1}$ above doublet-D. Laporte has predicted[13] that this difference will be about 11000 cm.$^{-1}$.

My plan is to extend the analysis of the La I spectrum in connection with investigations of the Zeeman-effects and hyperfine structures of the spectral lines. I take this opportunity to thank Dr King and Miss Carter for their kindness in lending me their tables of intensities and temperature classes in advance of publication, and I wish also to acknowledge the helpfulness of Professor Moore's observations of Zeeman-effects in giving clues for this analysis.

PLANT ECOLOGY.—*The soil reactions of some saprophytic orchids.*[1]

EDGAR T. WHERRY, Bureau of Chemistry.

The soil reaction preferences of a number of native orchids have been recorded by the writer in three previous papers, the most complete list of data being in "Soil Acidity.[2]" Subsequent to the preparation of that article opportunities have been presented to study many of the included species further, as well as to extend the work to others. The results to date on the saprophytic species commonly known as Coral-roots are here tabulated, and supplementary notes on a color form of one of them and the range of another are given.

TABLE 1—SOIL REACTIONS OF SEVEN SAPROPHYTIC ORCHIDS

SPECIES STUDIED (C = CORALLORRHIZA) (H. = HEXALECTRIS)	STATES IN WHICH TESTS WERE MADE	NUMBER OF TESTS	SOIL REACTION-RANGE AND APPARENT OPTIMUM (X)								
			Medi-acid		Sub-acid		Minim-acid		Neutral	Minim-alk	
			High	Low	High	Low	High	Low		Low	High
C maculata (mult)	Md -Me	25	–	x	X	x	x	–	–	—	—
C odontorhiza	Va -Md	50	–	x	x	X	x	—		--	
C trifida (Cor)	N Y -Me	25	—	x	x	x	X	x	x	—	—
C. wisteriana	Va -Md	25	—	–	--	x	x	X	x	x	
C striata	Mich -Ont	10	-		-	—	x	X	x	x	--
C micrantha	Fla	5	—	—	—	—	--	x	X	x	—
H. spicata (aph)	Fla -Md	25	—	—	—		x	x	X	x	x

The data presented in Table 1 have been obtained chiefly by stirring up the soil from the immediate vicinity of the plant roots with four times its volume of distilled water, allowing the mixture to settle for several minutes, and determining the active acidity or alkalinity of the extract with a double-wedge comparator. The summarized results are grouped in reaction-classes designated by names rather than by numerical values, in accordance with suggestions recently published in "Soil Reaction in Relation to Horticulture.[3]"

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[13] LAPORTE, Zeitschr f Phys 39: 123. 1926

[1] Received Dec. 13, 1926

[2] Smithsonian Report 1920: 204 1922

In the course of these studies a well-marked pale form of the Autumn Coral-root, *Corallorrhiza odontorhiza* Nutt., has been recognized, and as no such form of this species appears to have been named, it is here placed on record as:

Corallorhiza odontorhiza forma **flavida** n. f.—Plant in every respect like the typical form of the species except in the lack of all traces of purple color, the lip being pure white without spots, and the sepals, ovaries, bracts, and stem being dull yellow, of varying shades of Ridgway's no. 23.

Type locality, ravine west of Pierce Mill, Washington, D. C., just outside of Rock Creek Park, in the Piedmont physiographic province; collected by Mrs. Nellie C. Knappen, September 15, 1924; type specimen in the U. S National Herbarium, no. 1,285,622

A large colony was found by the writer a few hundred meters north of Bull Run Postoffice, Fairfax County, Virginia, October 13, 1926, also in the Piedmont, and the accompanying illustration is made from a photograph taken there Three stalks from this locality have been deposited in the National Herbarium, preserved in a mixture of acetic acid, ethanol, formaldehyde, and glycerol, in which their color and texture appear to remain essentially unchanged The habitat at both localities is a thin oak-pine woods on clayey soil, of low subacid reaction, active acidity 10–25, (pH 6.0–5 6).

It is also desired to place on record an extension of range of the Crested Coral-root *Hexalectris spicata* (Walt.) Barnhart. The northernmost locality at which this plant appears to have been reported in the literature is Williamsburg, in the Coastal Plain of Virginia, where it was found by the late E. J. Grimes.[4] There are, however, specimens in the U. S. National Herbarium collected by Miss M. J. Rathbun at Delaplane, in the Blue Ridge of Virginia, considerably further northwest. In mid-August, 1923, a single flowering stalk of this species was found by Miss F. W. Layton on an islet in Rhodes River, about 12 kilometers southwest of Annapolis, in Anne Arundel County, in the Coastal Plain province of Maryland, its range being thus extended into a new state, and to a point 150 kilometers north of Williamsburg and 125 kilometers east of Delaplane. The plant was pressed and deposited in the National Herbarium. In July of the following year another stalk appeared a few meters away; this was not disturbed, but did not reappear in 1926, nor could any trace of the species be found this year in spite of the most careful search of the vicinity. Evidently, as in the case of certain other native orchids (*e.g.*, *Basiphyllaea corallicola, Isotria verticillata, Triphora trianthophora,*) the roots may lie dormant in the ground for two years or more without sending up flowering stalks, but in time attain sufficient vigor to bloom, produce seed, and so keep the species from dying out.

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[3] Amer Hort. Soc Bull 4. 1926.

[4] Rhodora 24: 150 1922

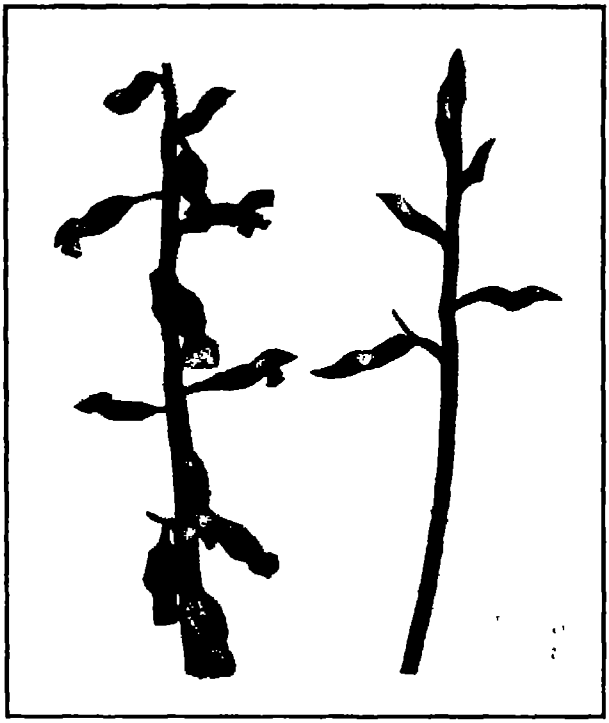

Fig. 1.—*Corallorrhiza odontorhiza* forma *flavida* n f Bull Run, Va

The Crested Coral-root has been studied at a number of localities, and proves to be essentially a neutral, calcareous soil plant. In Tennessee it has been observed to grow both in the cedar glades, rooted in small accumulations of alkaline soil in crevices of limestone rock, and in rich woods in the mountains, where the rocks are not calcareous, but local conditions have favored the thorough decomposition of plant debris into neutral leaf-mold. The habitat at Delaplane, Va., corresponds to the second of these. Along the Atlantic Coast the soils are predominantly acid, but coquina and shell-marl outcrop in some places, and masses of oyster-shells accumulated by the Indians provide a source of lime for soil-neutralization elsewhere. At the localities of this orchid observed in Florida—where, by the way, it blooms in May, not July or August, as sometimes stated—the soil is sandy, but shell material of one or the other of these origins lies not far beneath the surface, so that the reaction is essentially neutral. The same relation holds at the town of Bluffton, S. C., at the south edge of which a large colony occurs, blooming in mid-June. At Williamsburg, Va., the lime comes from a stratum of large Pecten shells. The Rhodes River islet, on which the plant reaches its northeasternmost known point, is underlain chiefly by clay giving rise to acid soil, but at one end there is a thin deposit of oyster-shells, evidently marking a temporary Indian settlement, and it is here that the plant has obtained a foothold. The seeds which started this colony presumably came from as yet undiscovered localities along the shores of Chesapeake Bay or adjacent estuaries, where calcareous outcrops are occasional, and it would be interesting to search for these, although the encroachment of civilization has probably destroyed most of them.

ENTOMOLOGY.—*Notes on and descriptions of Syrphid flies of the subfamily* Cerioidinae.[1] RAYMOND C. SHANNON, Bureau of Entomology. (Communicated by S. A. ROHWER.)

Considerable additional information on the *Cerioidinae* which may be regarded as supplemental to my previous paper on this group, "The Syrphid-flies of the subfamily Cerioidinae in the U. S. National Museum Collection,"[2] was obtained by the writer while examining certain European collections during a trip to Europe in the summer of 1925.

I wish especially to thank Professor Hervé-Bazin, Major E. E. Austen, and Professor Mario Bezzi for the facilities they afforded me in this work.

The Cerioidine flies are the most attractive in appearance of the *Syrphidae* and this, together with their comparative rarity, have made them highly prized by collectors. There appears to be a sur-

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[1] Received Nov. 16, 1926.

[2] Ins Ins Mens 13: 48-65 1925

prisingly large number of species for the unusual type of development which characterizes the subfamily. More than 120 species are known, mostly from the tropics, and, as a rule, the species are very distinct in form and color. Comparatively few synonyms (about ten) have been made in the group, although thirty writers have proposed names for the species.

The resemblance of the different species of *Cerioidinae* in appearance and behavior to various species of *Hymenoptera*, combined with the coincidental occurrence of the resemblants in the same region, is extraordinary and seemingly indicates true mimicry. Most of them simulate different species of wasps while a few have the appearance of certain saw-flies. The two most striking features of their similarity are the greatly extended antennae (long in the *Hymenoptera* and short in most *Syrphidae*) and the greatly constricted abdomen in the majority of the forms of these flies. The species resembling saw-flies have the abdomen broad throughout but the anterior corners are yellow, giving the flies the offhand appearance of having the abdomen petiolate basally.

One of the latter group, from Australia (*Tenthredomyia mellivora*), has been reared from larvae found feeding on the honey in the nest of a species of native bee. Mr. Rohwer has shown me a species of saw-fly, *Pterygophorus cinctus* Klug, from the same region which it closely resembles. The larvae of this genus of saw-flies are gregarious and feed on the foliage of the eucalyptus trees. Froggat has recorded that cattle are poisoned and killed when they feed upon these larvae which are migrating down the tree trunks. It is possible that the adult saw-flies retain the poisonous qualities of the larval stage and, if this is the case, it may be that they are purposely let alone by predaceous enemies. This, if true, would indicate that the resemblance which the fly bears to the saw-fly may be of more importance than mere chance resemblance.

The pupa of a number of species of *Cerioidinae* have been found on tree trunks but only in one other species, *Cerioides conopoides* (Linnaeus) is there anything known of the larval habits of these flies. Larvae of *C. conopoides* have been found in the sap of diseased poplars and other trees and in ulcers on elms.

Prior to the writer's paper, noted above, only one generic name, *Cerioides*, was valid in the subfamily. Two others, *Ceria* and *Sphiximorpha*, have been repeatedly used, sometimes for the purpose of indicating generic differences between species, although *Ceria* is a preoccupied name and *Sphiximorpha*, at the time of its erection, was given the same genotype which had been previously assigned to *Cerioides*.

In the writer's treatment of the subfamily, four genera, *Cerioides*, *Monoceromyia* (originally considered as a subgenus[3]), *Tenthredomyia*, and *Polybiomyia* (the last two being newly proposed) were recognized; and, insofar as the material (rather limited in exotic forms) at hand permitted, the species were located in their respective genera. Moreover, he called attention to the apparent absence of another generic type, as follows: "It appears that there should be a fifth group or genus which is not represented in the material at hand. It should be of a more generalized nature characterized by an unconstricted abdomen and a short or absent antennifer."

A species which fits these requirements was found in the collection of M. Hervé-Bazin, namely *Cerioides petri* Hervé-Bazin, from Kumanotaira, Karuizawa, Japan. This species is made the type of the new genus *Primocerioides*.

The writer has examined seventy-seven species of *Cerioidinae* (27 species recorded in his first publication) and finds that all of them may be placed without difficulty in the four genera he defined in his previous paper, except *C. petri* Hervé-Bazin, which, as has just been stated, becomes the type of a new genus. The species not seen by the writer have been located in their respective genera as well as the published descriptions will permit. A list of the genera with the species which they contain is appended at the end together with the distribution of each species.

The geographic distribution of the genera turns out to be remarkably consistent.

Primocerioides (1 species)—Palearctic (Japan).
Tenthredomyia
  Subgenus *Tenthredomyia* (16 species)—Holarctic, usually northern latitudes or high altitudes (such as the Canadian zone).
  Subgenus *Pterygophoromyia* (3 species)—Australia
Monoceromyia (40 species)—Mainly in the tropics of both hemispheres. Two species occur in Australia, twelve in Africa, none in Europe or temperate America.
Cerioides (35 species)—In all continents
Polybiomyia (15 species)—Tropical America and southwestern United States; one species from Malaysia (Aru Islands) and one from Natal, Africa.

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[3] Bull Brook Entom Soc 16. 33 1922

Cerioides is the most widely distributed of the genera and at the same time contains the most diverse set of species.

Polybiomyia is mainly confined to the new world. The occurrence of one species of the genus, *P. smaragdina* (Walker), remarkable for its entirely green metallic coloration, in the Aru Islands of Malaysia, is of particular interest inasmuch as *Crepidomyia ventralis* (Walker), a genus and species of the *Xylotinae*, also occurs in the Aru Islands; all other species of *Crepidomyia* are known only from South America. *Polybiomyia divisa* (Wiedemann), recorded from Natal, Africa, is peculiar in its venation and could well be considered as a different subgenus.

Pterygophoromyia, a subgenus of *Tenthredomyia*, differs from all other *Cerioidinae* (except *Primocerioides?*) in having a plumose filament (the plumula) attached to the thorax just below the squama, the absence of which was formerly considered to be one of the characters of the subfamily.[4]

KEY TO THE GENERA OF CERIOIDINAE

A 1. Antennal process (antennifer) very short or absent, rarely equaling half the length of first antennal joint.
  B 1 Abdomen not constricted basally; eyes pilose **Primoceriodes**, new genus
  B 2 Abdomen constricted basally, eyes bare.
    C 1 Metasternum membranous behind . **Cerioides** Rondani
    C 2. Metasternum completely girdled with chitin **Polybiomyia** Shannon
A 2 Antennifer very elongate, distinctly longer than first antennal joint
  B 1. Abdomen very slightly and progressively narrowed basally, anterior corners bright yellow . **Tenthredomyia**, Shannon
    C 1. Plumula absent **Tenthredomyia**, *sensu stricto*
    C 2 Plumula present . **Pterygophoromyia**, new subgenus
  B 2 Abdomen strongly constricted at juncture of the first and second segments, usually the main length of the second segment contracted into a long petiole . **Monoceromyia**, Shannon.

Primocerioides, new genus

Genotype *Cerıodes* (sic!) *petri* Hervé-Bazin, Ann Soc Entom. France **83**: 414 1914.

The characters given in the key will serve to distinguish this new genus The absence of the antennifer and the nonconstricted abdomen mark this genus as the most generalized one in the sub-family *Cerioidinae*.

The genotype, which is peculiar in several respects, is the only species known in this genus. The pubescence is unusually developed, the eyes and face being distinctly pilose; the first antennal joint is long, the second short, and the third fairly long; the third longitudinal vein is straight and bears an appendix projecting into the first posterior cell.

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[4] SHANNON, *A reclassification of the subfamilies and genera of North American* Syrphidae, Bull. Brook Entom Soc **16**: 67. 1921

Only the type specimen, a male, in the collection of M. Hervé-Basin, is known.

Type locality, Kumanotaira, Karuizawa, Japan.

AUSTRALIAN CERIOIDINAE

Four species of *Cerioidinae* have been described to date from Australia. Three other species are now at hand and a possible fourth has been mentioned in a paper by G. H. Hardy, "Notes on some Australian Syrphidae." This latter species may be the same as the one described below as *Monoceromyia hardyi*, new species.

KEY TO SPECIES OF AUSTRALIAN CERIOIDINAE

A 1 Antennifer not developed, abdomen constricted basally, third vein moderately curved downwards, without appendix on the loop **Cerioides breviscapa** (Saunders)

A 2 Antennifer very elongate, longer than first antennal joint

  B 1 Abdomen not constricted basally, plumula present TENTHREDOMYIA (Subgenus PTERYGOPHOROMYIA)

    C 1 First tergite entirely orange red, second almost entirely black without callosities, third tergite of male with a prominent tubercle **T. saundersi** Shannon

    C 2 First tergite blackish with yellow anterior corners; second largely yellow with a pair of lateral callosities, the third without tubercle

      D 1 Meso- sterno- and pteropleura with yellow **T. ornata** (Saunders)

      D 2 Mesopleura only with yellow **T. mellivora,** new species

  B 2 Abdomen strongly constricted basally, plumula absent MONOCEROMYIA

    C 1 Thorax without yellow markings except on the humeri, notopleurae and scutellum, wings entirely infuscated **M. induscai** new species

    C 2 Thorax with numerous yellow markings, wings infuscated only on anterior border **M. hardyi,** new species

CERIOIDES BREVISCAPA (Saunders)

Ceria breviscapa Saunders, Trans Entom Soc London **4**: 65. 1847.
Cerioides breviscapa (Saunders) Hardy, Australian Zoologist **2**: 13 1921

This species has some affinities with species of *Monoceromyia* and *Tenthredomyia*

Originally recorded from Port Philip, South Australia. Hardy reports one specimen from South Australia and four from New South Wales.

Type.—In the British Museum

Genus TENTHREDOMYIA Shannon

Subgenus **Pterygophoromyia,** new subgenus

TYPE - *Tenthredomyia saundersi* Shannon

The subgenus *Pterygophoromyia* is characterized by the presence of a small but distinct plumula (a plumose filament attached to the thorax just below the squama). The subgenus, so far as known, is confined to Australia.

TENTHREDOMYIA (PTERYGOPHOROMYIA) ORNATA (Saunders)

Ceria ornata Saunders, Trans. Entom. Soc. Lond. **4**: 64, *pl. 4, fig 3, 3a, 3b.* 1845.
Ceria australis Macquart (synonym?) Dipt Exot. Suppl. **4**: 128. 1849.
"*Cerioides ornata* Saunders," Hardy, Australian Zoologist **2**: 13. 1921.
Tenthredomyia australis (Macquart) Shannon, Ins. Ins Mens. **13**: 54. 1925.

A male specimen at hand (previously recorded by the writer as *T. australis* Macquart) agrees with *T. ornata* except in some particulars found in the original description as regards the abdominal coloration The original description and figure indicate that the basal segment is reddish, margined behind with yellow, with the anterior corners yellow and equal in length to the second segment The female is figured and shows only four segments, the first of which equals the third in length There should be five segments shown for the female, and apparently that which is intended for the first is the first and second combined, which together equal the length of the third. The specimen at hand differs from the description and figure in having the first segment more extensively darkened; but it agrees otherwise with the type of *C ornata* according to my examination of the type. The type of *C ornata* has the fourth tergite margined behind with yellow, contrary to the impression given in the description

The description of *C. australis* (Macquart) agrees with *T. ornata* except that the first antennal joint is stated to be as long as the antennifer, and in the figure given for *C. australis* the first joint is shown to be as long as the antennifer and equal in length to the following two combined. The first joint in *T ornata* is scarcely more than half the length of the antennifer and the three joints are nearly of equal length.

Hardy states under "*Cerioides ornata* Saunders" that there were two species standing in the collection of the Macleay Museum under this name One was characterized by a pair of callosities on the second segment, the other not having these callosities. These callosities are present in *T. ornata* (Saunders) and *T. mellivora* (new species, described below) but are absent in *T saundersi*. They are less developed in the female than in the male.

Tenthredomyia (PTERYGOPHOROMYIA) **mellivora**, new species.

Closely related to *T. ornata* Saunders Differs chiefly in having the yellow on the pleurae confined to the mesopleura and in having the second sternite black with the hind margin yellow and the third tergite entirely black In *T. ornata* the second tergite is almost entirely yellow and the hind margin of the third is yellow The ocellar triangle of the male is equilateral and the callosities on the second tergite are more prominent than in *T. ornata*. In the female the eyes converge as closely together at the vertex as in the male but widen rapidly downwards, the center of the front has a very large black spot which includes the ocelli The fifth tergite is obscurely reddish yellow. Length, about 12 mm., not including antennifer which is 1 5 mm , antennifer and antenna combined, 5 mm , wing 13 mm

Described from two males and four females, eight additional specimens are in the British Museum.

Type.—Male, allotype female, in the British Museum, paratypes in the U. S. National Museum Cat. No 40105 U. S. N. M

Two specimens have been reared and the puparia are mounted with the specimens and bear the label "Larvae live on honey in native bee's nest " (Note by donor).

Type locality.—Burpengary, South Queensland, (T. L Bancroft)

TENTHREDOMYIA (PTERYGOPHOROMYIA) SAUNDERSI Shannon

Tenthredomyia saundersi Shannon, Ins. Ins. Mens. **13**: 53. 1925.

Original description based on a single male The collection of the British Museum contains one male and four females. The species is nearest to *T. ornata* Saunders. In addition to the characters given for the male in the original description attention may be called to the differences existing between the females of the two species The front is much narrower in *T. saundersi* and widens rather gradually downwards; the black spot on the front is much smaller and below the middle; first tergite reddish yellow, the sides yellow, a little darkened at the middle of the hind margin; second tergite velvety black with a bright yellow hind margin; abdomen without callosities; the yellow spot on the pleurae confined to the mesopleura.

Type.—In U. S National Museum.

Type locality—New South Wales: Sidney (January, 1900, Mackay).

Other localities.—Queensland: Burnett River (T. L. Bancroft), Mackay (G Turner)

Genus MONOCEROMYIA Shannon

Monoceromyia SHANNON, Bull Brook. Entom Soc **17**: 32 1922; Ins. Ins Mens **13**: 50 1925

The only intimation of the occurrence of this genus in Australia was that given by Hardy in the Australian Zoologist (vol. 2, p 13, 1921) He calls attention in this publication to a species occurring in Queensland and New South Wales which has a greatly constricted abdomen and has the third vein of the wing deeply looped into the first posterior cell. No mention is made of the length of the antennifer, but a further characteristic noted by Hardy, namely, that the wing is infuscated above the third vein except the area within the deflected portion of the third vein, indicates a possible relationship with the species here described under the name *M. hardyi*.

Monoceromyia hardyi, new species

Male—Rather small species, mostly dark with reddish yellow and yellow markings. Ocellar region black, remainder of vertex yellow; frontal triangle yellow, very broad and short, antennifer yellowish brown, distinctly longer than first antennal joint; antenna reddish brown, relative length of joints 1·0 75· 0.60; the base of the third joint nearly equal to its length; style two-thirds the length of the third joint, dark brown; face bright yellow with a black median stripe extending from base of antennae to oral margin and on each side of the face a black stripe extending from the oral angle upwards to the eye, thorax black, humeri and notopleural regions yellow, a pair of small, submedian, prescutellar, yellow spots and another pair of more elongate, sublateral spots which spread on to the postalar calli; scutellum yellow with median black spot bordering on anterior margins, meso- and sternopleurae with yellow spots, the pteropleura partly reddish yellow; legs largely reddish yellow, the femora and tibia partly dark brown, abdomen rather strongly constricted at juncture of first and second segments, third and fourth segments globose; first and second tergites reddish yellow, third and fourth black with reddish yellow hind borders; hypopygium reddish brown, anterior border of wing deeply infuscated, the third vein deeply looped into first posterior cell, without appendix on the loop, the portion of the wing within the deflection and behind the third vein hyaline. Length 11 mm., plus antennifer 12 mm ; wing 8 mm.

Type.—Male, in British Museum.

Type locality.—Queensland: Brisbane (November 12, 1912, H. Hacker).

Named for G. H. Hardy, student of Australian *Syrphidae*.

Monoceromyia austeni, new species

Male.—A larger species than the above, from which it is easily differentiated by the separated eyes, which at their greatest approximation are further apart than the width of the first antennal joint, antennifer and antennae entirely reddish brown; face slightly concaved, rising below to a moderate, keel-like tubercle; thorax black except for humeri and notopleural callosities and hind margin of the scutellum; legs reddish brown, all the femora with rather broad, subbasal dark bands, abdomen strongly constricted on basal half of second segment; first tergite black; second yellow on basal half with a dorsal, median dark line; posterior half of second tergite black, third and fourth tergites blackish with narrow yellow hind borders, hypopygium reddish brown; wings entirely smoky; third vein with loop and a short appendix attached to loop. Length 13 5 mm., with antennifer 14 60 mm., wing 11 mm.

Type—Male, in British Museum.

Type locality—Queensland: Brisbane (November 24, 1912, H. Hacker).

Named for Major E. E Austen, the noted dipterologist of the British Museum.

NEW SPECIES OF ASIATIC CERIOIDINAE

Cerioides meijerei, new species

Large, nearly black species, very close to *C fruhstorferi* de Meijere.

Female—Head black, sides of face with a large yellowish spot and a smaller one on eye margin opposite antennal base; antennifer very short, its length about half its breadth, antenna black; first and second joints very elongate, of equal length, the third very small, but little longer than broad, style black; mesonotum black with a very obscure yellow spot on humerus and notopleura, hind margin of scutellum yellowish; pleurae black with an obscure yellowish stripe on mesopleura, legs almost entirely dark reddish brown. abdomen blackish; anterior corners faintly yellowish; petiole of second segment dark brown, second segment greatly constricted and elongate, the two basal segments equal in length to remainder of abdomen, hind margin of third tergite narrowly reddish brown; anterior half of wing deeply infuscated, posterior half faintly infuscated; third vein deeply looped into first posterior cell, the loop without an appendix. Length 18 mm.; wing 13 mm. One female

C. fruhstorferi differs in having the yellow facial markings much smaller and in having the third vein but little deflected.

Type—In British Museum

Type locality.—Indo China: Haut Mekong. Tong Lap. (March 30, 1918, R. V. de Salvaza).

Named for Professor J. C H. de Meijere, who has worked extensively on the *Cerioidinae* as well as many other groups of *Diptera*.

Tenthredomyia brunettii, new species

Rather small species, superficially related to *Monoceromyia dimidiatipennis* (Brunetti) of India and resembling the North American species *T. tridens* (Loew) and *T. anchoralis* (Coquillett).

Male and female.—Head yellow with black markings as follows: Male, a stripe extending from foremost ocellus to the occipital margin, a spot on each side between the base of antennifer and eye, a small median stripe which fades out half way to the antenna; a black stripe on each side extending between oral margin and eye. Female, the ocellar markings extend as a stripe from the occipital margin to the ocelli, whence a fork extends from each side to the eye, and, continuing along the eye margin, come together and in so doing inclose a yellow spot which lies before the ocelli. Antennifer yellow below, black above, twice the length of first antennal joint which in turn is about equal to the length of each of the other two joints, lower portion of head, behind the lower facial stripes, bright yellow, the yellow of the humerus and notopleura converging into a single spot; a pair of sublateral mesonotal stripes behind the suture; scutellum entirely yellow; meso-sterno- and pteropleurae with yellow, femora yellow, more or less marked with black preapically, tibiae yellow, more or less darkened apically; tarsi more or less darkened, first tergite black with yellow sides, the yellow converging basally; second, third and fourth tergites black with yellow hind borders, hypopygium of male and fifth tergite of female black; anterior border of wing irregularly infuscated, hyaline behind. Length 11 mm, plus antennifer 12 mm.; wing 8 mm. Two males, one female

Type male and *allotype* female.—In British Museum.

Type locality—British Baluchistan: Quetta (June 2, 1902, C. G. Nurse).

Monoceromyia dimidiatipennis (Brunetti) most closely resembles this species. Besides the abdominal constriction it differs in being more extensively black. The post oral region is black, the humeral and notopleural yellow markings are separated, and no yellow occurs on the pteropleura.

Named for Mr E. Brunetti, in recognization of his contributions to our knowledge of Indian *Diptera*.

Tenthredomyia hungkingi, new species

Approaches *Tenthredomyia tridens* (Loew) of North America very closely in size, structure, and color.

Female—Head largely black, the posterior orbit (space between upper occipital margin and hind margin of eye to ocelli to eye) yellow, a yellow spot present above each antenna; the face yellow with a median black stripe from base of antennifer to oral margin, antennifer reddish yellow, antennae black, mesonotum black, humeri, a small spot on notopleura, a pair of sublateral, postsutural stripes and scutellum yellow, yellow marking on pleurae confined to meso- and sterno-pleurae; legs reddish yellow, femora more or less darkened around the middle, first tergite black with anterior corners yellow; second, third and fourth tergites black with rather narrow yellow hind borders; fifth tergites black, wings infuscated on anterior half. Length 12 mm, plus antennifer 13 mm; wing 10 mm. Two females.

T tridens differs in having the yellow on the posterior orbit divided by the black extending from the ocellar region, the pteropleura partly yellow and the yellow on the hind borders of tergites two, three, and four expanding on their outer ends (contracting in *T. hungkingi*, particularly on the fourth tergite)

Type.—In British Museum.

Type locality—China: Haikon, near Tientsin, (June 17, 1906, F. M. Thomson) Tientsin, (June 15, 1906, F. M. Thomson).

Named for Teou Hung-King, (452-536 A D) one of the first Chinese naturalists to record observations on *Syrphidae*—namely *Eristalis tenax* (Linnaeus).

Monoceromyia salvazai, new species

A large, nearly black species.

Male.—Face yellow, flat, with a median raised line extending from antennifer to oral margin which is black; a yellow spot on eye margin opposite base of antennifer; remainder of head black; antennifer and antennae black; antennifer nearly as long as two basal antennal joints, third joint a little more than half the length of second, style black basally, white apically; thorax black with only hind margin of scutellum obscurely yellow; legs largely blackish, the femora apically becoming reddish brown, abdomen strongly constricted at second segment which is as long as the third and fourth combined and reddish brown on the more constricted portion, abdomen otherwise black: wings infuscated anteriorly; third vein sharply looped downwards and with an appendix attached to loop. Length 21 mm., with antennifer, 23 mm.; wing 14 mm. One male.

M. obscura (Brunetti) resembles *M. salvazai* in general appearance and color but is a smaller and more slender species with the mesonotum subquadrate. In *M. salvazai* the mesonotum is much longer than broad.

Type.—In British Museum.

Type locality.—Luang Prabang: Ban Sen Savouane (March 16, 1920, R. V. de Salvaza).

Named for Mr. R. V. de Salvaza, the collector.

Monoceromyia wiedemanni, new species

Fairly large, nearly black species, very closely allied to *M. obscura* Brunetti.

Male.—Head black, a pair of yellow spots, one on eye margin opposite base of antennifer, and a large yellow marking on each side of face, antennae black, the joints of equal length, the basal two equal to length of antennifer; style grayish, thorax black with yellow only on the humeri and hind scutellar margin; legs brownish black, abdomen strongly constricted at second segment, which is as long as the following two segments, the constricted portion brownish, extreme hind edge of third tergite brown, slightly raised, remainder of abdomen shining black, the fourth tergite towards the hind margin with a deeply impressed transverse line, wings deeply infuscated anteriorly, third vein moderately looped downwards. Length 15 mm., with antennifer, 16.5 mm., wing 11 mm. One male.

M. obscura differs in having the antennifer shorter, less than length of the two basal antennal joints; the frons yellow in the male, and no constriction before the hind margin of the fourth tergite.

Type.—In British Museum.

Type locality.—Indo China: Luang Prabang, Ban Nam Mo. (March 3, 1918, R. V. de Salvaza).

Named for C. R. W. Wiedemann, the first to describe a species of *Ceriodinae* from the Asiatic region (*Ceria javana*, 1824).

Monoceromyia wallacei, new species

A rather large species, predominantly black, with yellow and brownish markings. Closely allied to *M. tridecimpunctata* (Brunetti).

Female.—Head black, a yellow spot on eye-margin opposite base of antennifer; face with a broad yellow stripe on each side; antennifer reddish yellow, antennae reddish brown, first joint a little longer than second which is equal to third; the two basal joints equal to antennifer, thorax with yellow on the humeri, a small spot on notopleura, a pair of postsutural stripes, hind margin of scutellum, and part of the meso- and sternopleura; legs reddish brown, tarsi darker, basal halves of tibiae yellowish; anterior corners of first tergite yellow, sides of constricted portion of second tergite yellowish brown, hind margins of second, third and fourth tergites narrowly yellow, all three of which are slightly rimmed; fifth tergite black; wings dilutely infuscated on anterior margin; third vein moderately looped, without appendix. Length 17 mm., with antennifer 18.5 mm ; wing 14 mm. Described from one female.

Type—In British Museum

Type locality—Celebes: Macassar (1857, A. R. Wallace).

Named for the famous naturalist, A. R. Wallace, who collected it.

Monoceromyia hervebazini, new species

A large black species with yellow markings

Male—Face yellow with a median longitudinal black stripe which at the base of the antennifer sends out arms to the eye margins, remainder of head black, antennifer and antenna blackish, last joint dark brown, style whitish; thorax black with humeri yellow, a small yellow spot at outer end of transverse suture, meso- and sternopleurae partly yellow, legs reddish brown, more yellowish on basal half of hind femur, first tergite black; the second constricted and elongated, one-fourth longer than the third, yellowish on the most slender portion, with a dark median stripe, posterior third broadened, blackish, third tergite black, hind border yellow, the sides rimmed, the impressed line crossing the tergite along the anterior margin of the yellow border; fourth tergite black, the sides rimmed, the impressed line crossing the tergite near its hind border and producing a deep constriction, behind the constriction the tergite is brownish, with the extreme hind edge yellow, hypopygium black; wing rather dilutely infuscated on basal and anterior half, leaving the outer posterior quarter, nearly hyaline, length 18 mm., plus antennifer 19.5 mm., wing 14 mm. Two males.

Monoceromyia trinotata de Meijere has the third and fourth tergites deeply constricted near the hind margins by means of impressed lines, but this species is smaller, more slender, second abdominal segment much more elongate and possesses a number of yellow markings which are absent in *M. hervebazini*.

Type—In British Museum

Type locality—Shanghai, China (1854, Fortune).

Named for M. Hervé-Bazin, an eminent dipterist of France, who is greatly interested in the Chinese fauna, having made a very extensive collection there

KEY TO THE ASIATIC SPECIES OF CERIOIDINAE AT HAND

(Measurements do not include antennifer)

A 1 Antennifer undeveloped; third vein deeply looped, abdomen strongly constricted basally, black species with yellow facial markings; 18 mm. (Indo China). . . . . . **Cerioides meijerei** Shannon

A 2. Antennifer greatly elongated.

- B 1. Abdomen not, or very slightly, constricted basally, with yellow apical corners: TENTHREDOMYIA.
  - C 1. Thorax with yellow only on humeri and disk of scutellum. (China) **T. grahami** Shannon

C 2. Pleurae with yellow and additional yellow markings on mesonotum

D 1. Yellow on notopleura confluent with yellow on humeri, pteropleura partly yellow (Baluchistan). **T. brunettii,** Shannon

D 2. Yellow on notopleura widely separated from that on humeri, pteropleura without yellow (China) **T. hungkingi** Shannon

B 2. Abdomen strongly constricted at second segment, with or without yellow basal corners: MONOCEROMYIA

C 1. Third tergite equal to or longer than the second, pleurae without yellow markings, 20 mm. (China) .. **M. pleuralis** (Coquillett)

C 2. Third tergite much shorter than second

D 1. Entire body, including wings, blackish except a pair of narrow, yellow facial stripes and white style, 25 mm. (Philippines) **M. petersi** (Speiser)

D 2 Wings with strong contrast between the infuscation on anterior border and the hyalinity of posterior border; head and usually the body with more yellow

E 1. Pleurae entirely black

F 1 Thorax black except hind scutellar margin; male without deep impressions on tergites, 20 mm (Indo China) **M. salvazai,** Shannon

F 2 Thorax with humeri at least obscurely yellow.

G 1 Antennifer as long as combined length of first and second joints, 15 mm. (Indo China) **M. wiedemanni** Shannon

G 2 Antennifer shorter than the two basal joints 15 mm (India) **M. obscura** (Brunetti)

E 2 Pleurae marked with yellow.

F 1 Meso-sterno- and pteropleurae marked with yellow

G 1 Post oral region black; mesonotum without post sutural markings or prescutellar spot, scutellum yellow with a median black spot dividing the yellow; 20 mm (Malasia) **M. javana** (Wiedemann)

G 2 Post oral region yellow, mesonotum with a pair of yellow post sutural stripes and a prescutellar spot, scutellum black, the hind margin yellow, 16 mm (India) **M. trinotata** (de Meijere)

F 2 Meso- and sternopleurae only with yellow, mesonotum with a pair of post sutural yellow stripes.

G 1. Post oral region yellow, 16 mm (India, Malacca?) **M. ?tridecimpunctata** (Brunetti)

G 2 Post oral region black; 18 mm (Celebes) **M. wallacei** Shannon

F 3. Mesopleura only with yellow; post sutural stripes obscure brown, 16 mm (China) **M. wui** Shannon

LIST OF THE SPECIES OF CERIOIDINAE

Arranged according to the present generic concept Those species marked by an * have been examined by the writer

PRIMOCERIOIDES Shannon

*petri (Hervé-Bazin) (Cerioides) Japan

Cerioides Rondani

North and Central America and the West Indies

cylindrica (Curran) (Ceria)	California
*durani Davidson	Arizona
*loewii (Williston) (Ceria)	California
ontarioensis (Curran) (Ceria)	Ontario
signifera (Loew) (Ceria)	U. S. (?) Mexico
*willistoni (Kahl) (Ceria) = signifera (Loew)?	Pa., Md., La., Tex.

South America

*barbipes (Loew) (Ceria)	Brazil
bigotii (Williston) (Ceria)	Brazil, Bolivia
boliviana (Kertesz) (Ceria)	Bolivia
*braueri (Williston) (Ceria)	Brazil
facialis (Kertesz) (Ceria)	Paraguay
flavosignata (Kertesz) (Ceria)	Bolivia, Peru
*meadei (Williston) (Ceria)	Brazil
*mikii (Williston) (Ceria)	Brazil
nigripennis (Williston) (Ceria)	Mexico
picta (Kertesz) (Ceria)	Boliva, Peru
pyrrhocera (Kertesz) (Ceria)	Bolivia
*roederii (Williston) (Ceria)	Brazil
sackenii (Williston) (Ceria)	Brazil
superba (Williston) (Ceria)	Mexico
trichopoda (Kertesz) (Ceria)	Bolivia
variabilis (Kertesz) (Ceria)	Bolivia, Peru
vicina (Kertesz) (Ceria)	Peru
wulpii (Williston) (Ceria)	Brazil, Bolivia

Europe, Western Asia, Northern Africa

*subsessilis (Illiger) (Ceria)	Europe, etc.

Asia and Malaysia

*decorata (Brunetti) (Ceria)	India
fruhstorferi (de Meijere) (Ceria)	India
fulvescens Brunetti (Ceria)	India
*meijerei Shannon	Indo China
triangulifera Brunetti (Ceria)	India

Africa

bezzii Hervé-Bazin

Australia

*breviscapa (Saunders) (Ceria)	South Australia

TENTHREDOMYIA Shannon

North America

*abbreviata (Loew) (Ceria)	Eastern North America
**proxima* (Curran) (*Ceria*) = *abbreviata* (Loew)	Canada, New England
*anchoralis (Coquillett) (Sphiximorpha)	New Mexico
pictula (Loew) (Ceria)	Southern United States
sartorum (Smirnov) (Cerioides)	Turkestan
*snowi (Adams) (Sphiximorpha)	New Mexico
*tridens (Loew) (Ceria)	West of the Rocky Mountains

Europe, Western Asia, Northern Africa

*conopoides (Linnaeus) (Musca)	Mediterranean countries, Persia
*vespiformis (Latreille) (Ceria)	Mediterranean countries

Asia, Malaysia

*annulifera (Walker) (Ceria)	New Guinea
*brevis (Brunetti) (Ceria)	India
*brunettii Shannon	Baluchistan
compacta (Brunetti) (Ceria)	India
*dimidiatipennis (Brunetti) (Ceria)	India
*grahami Shannon	China
*hungkingi Shannon	China
metallica (Van der Wulp) (Ceria)	New Guinea
ornatifrons (Brunetti) (Ceria)	India
relicta (Walker) (Ceria)	Aru Islands
(Saunders)? relictura (Walker) (Ceria)	Aru Islands

Australia

(Belongs to subgenus *Pterygophoromyia*)

australis (Macquart) (*Ceria*) = ornata (Saunders)?	Tasmania
*mellivora Shannon	South Queensland
*ornata (Saunders) (Ceria)	New South Wales
*saundersi Shannon	New South Wales

MONOCEROMYIA Shannon

North America

*cacica (Walker) (Ceria)	Mexico
*daphnaeus (Walker) (Ceria)	Jamaica
*tricolor (Loew) (Ceria)	West Indies, Florida
*veralli (Williston) (Ceria)	Panama

South America

bicolor (Kertesz) (Ceria)	Peru, Bolivia
lynchii (Williston) (Ceria)	Brazil

Europe

None

Asia and Malaysia

anchorata (Bigot) (Sphiximorpha) = lateralis (Walker)?	Borneo
annulata (Kertesz) (Cerioides)	Fuhosho, Toyenmongai
bakeri Shannon = petersi (Speiser)	Philippines
(Synonymy based on a comparison of *M. petersi* in Bezzi's collection.)	
crux (Brunetti) (Ceria)	India
*cumenioides (Saunders) (Ceria)	India
*fenestrata (Brunetti) (Ceria)	India
flavipennis (de Meijere) (Ceria)	India
*hervebazini Shannon	China
*himalayensis (de Meijere) (Ceria)	India
*javana (Wiedemann) (Ceria)	Malaysia
*lateralis (Walker) (Ceria)	Malaysia
*obscura (Brunetti) (Ceria)	India
*patricia (Brunetti)	India
*petersi (Speiser)	Philippines
*pleuralis (Coquillett) (Sphiximorpha)	Japan
*polistoides (Brunetti)	India
*salvazi Shannon	Indo China
similis (Kertesz) (Cerioides)	Formosa
tibialis (Kertesz) (Cerioides)	New Caledonia
*tridecimpunctata (Brunetti) (Ceria)	Indo China
*trinotata (de Meijere) (Cerioides)	India
*wallacei Shannon	Celebes
*wui Shannon	China
*wiedemanni Shannon	Indo China

Africa

afra (Wiedemann)	Cape of Good Hope
ammophilina (Speiser) (Cerioides)	Kilimandjaro
brunneipennis (Loew) (Ceria)	South Africa
*caffra (Loew) (Ceria)	South Africa
congolensis Bezzi	Belgian Congo
frenata (Loew) (Ceria)	Cape of Good Hope
*gambiana (Saunders) (Ceria)	Gambia
*hopei (Saunders) (Ceria)	Sierra Leone
maculipennis (Hervé-Bazin) (Cerioides)	Belgian Congo
*neavei (Bezzi) (Cerioides)	Uganda
*pulchra (Hervé-Bazin) (Cerioides)	Belgian Congo, Rhodesia
*speiseri (Hervé-Bazin) (Cerioides)	Uganda

Australia

*austeni Shannon	Queensland
*hardyi Shannon	Queensland

POLYBIOMYIA Shannon

North and Central America

arietis (Loew) (Ceria)	Mexico
*bellardii Shannon	Texas
*bergrothi (Williston) (Ceria)	Mexico
*captis Curran	Mexico
*engelhardti Shannon	Arizona
*macquarti Shannon	Texas, Mexico
*nigra (Bigot) (Sphiximorpha)	Mexico
*pedicellata (Williston) (Ceria)	Mexico
*rufibasis (Bigot) (Sphiximorpha)	Mexico
*sayi Shannon	Arizona
*schnablii (Williston) (Ceria)	Mexico
*schwarzi Shannon	Panama
*townsendi (Snow) (Ceria)	Texas, New Mexico, Arizona

Malaysia

*smaragdina (Walker) (Ceria)	Aru Islands

Africa

*divisa (Walker) (Ceria)	Natal

Errata to the "Syrphid-flies of the subfamily Ceriodinae," R. C Shannon,[5]
Ceriodinae, spell *Cerioidinae.*
Ceriodes, spell *Cerioides.*
acica Walker, p 64, spell *cacica* Walker
Quotation marks should be placed about the descriptions of *Polybiomyia captis* Curran and *Cerioides durani* Davidson, given in the keys, in order to give these authors full credit for these species.

SCIENTIFIC NOTES AND NEWS

Arthur M Piper has been appointed Assistant Geologist in the Geological Survey and has been assigned to the Water Resources Branch.

S. Spencer Nye, Junior Geologist in the Geological Survey, has been transferred from the Geologic Branch to the Water Resources Branch.

The twenty-fifth anniversary of the establishment of the National Bureau of Standards was celebrated on December 4, 1926, by an exhibit of apparatus and methods at the Bureau, a reception and luncheon, and a dinner in the evening at which Dr. S. W. **Stratton**, the first director of the Bureau, was a guest.

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[5] Ins Ins Mens 13: 48–65 1925

The annual exhibit representing work of the departments of the Carnegie Institution of Washington was held at the Institution on December 11 to 13, 1926.

Professor THEODOR VON KARMAN, dean of the Aerodynamic Institute of the University of Aachen, Germany, gave a series of six lectures at the National Museum on *Modern development of aerodynamic theories*, on December 3 to 13, under the auspices of the Daniel Guggenheim Fund for the Promotion of Aeronautics.

The Pick and Hammer Club met at the Geological Survey on December 11 W. T THOM reported on the symposium on the hypothesis of continental sliding, held at the New York meeting of the Association of Petroleum Geologists; and A C. LAWSON described his recent trip through Africa.

The Petrologists' Club met at the Geophysical Laboratory on December 14 G TUNELL described his observations on *Oxidation of low-grade porphyry copper ores*, H. E MERWIN and H S. WASHINGTON discussed *The relation of the optical properties to the composition of monoclinic pyroxenes;* and W. T. SCHALLER gave brief notes on *Hydrates of the borax group*

At a joint meeting of The ACADEMY and the Chemical Society on December 16, 1926, the first part of the program consisted of the presentation of the John Scott Medal and an award of one thousand dollars to Dr. HARVEY C HAYES of the Navy Department in recognition of his work on sonic sounding The presentation was made by a representative of the Board of Directors of City Trusts of Philadelphia, and was acknowledged by Assistant Secretary WARNER of the Navy Department and by Dr. HAYES The second part of the program consisted of a lecture by Professor J N BRONSTED, of the University of Copenhagen, on *The metal-amines and their significance for the physical chemistry of solutions.*

The ACADEMY held its annual meeting at the Bureau of Standards Tuesday evening, January 11 Dr G K BURGESS, the retiring president gave an illustrated address on the work of the Bureau, after which the laboratories were open for inspection, tests of various kinds being shown.

Initial arrangements are being made for the repair of the CARNEGIE during 1927 in accordance with the appropriation made by the Board of Trustees of the Carnegie Institution of Washington on December 10, 1926, for the rehabilitation of that vessel, which must precede the three-years' cruise to begin in 1928.

Mr GISH returned to Washington from his trip in Europe December 23 and is now preparing his report on the conferences held with various European scientists interested in earth-currents and atmospheric electricity

Mr. O DAHL, who was aviator and assistant to Dr. SVERDRUP during the Arctic Drift Expedition of 1922 to 1925, was appointed to the staff of the Department beginning January 1 and has been assigned to the work being done by Drs BREIT and TUVE

The time of the Third General Assembly of the International Union of Geodesy and Geophysics at Prague has been set, for the general meetings, from September 4 to 11, 1927; preliminary meetings of the various sections preceding the general meetings are expected to begin August 28.

Messrs. RALPH W. G WYCKOFF and STERLING B. HENDRICKS have resigned from the staff of the Geophysical Laboratory, Carnegie Institution of Washington, to take up X-ray investigation at the Rockefeller Institute for Medical Research, in New York.

Commander N. H. HECK has returned to Washington after completing inspection duty in the Hawaiian Islands

Professor A. S HITCHCOCK has returned from Cuba, where he spent about a month collecting grasses He visited the Jata Hills near Guanabacoa accompanied by Brother Léon of the Colegio de La Salle These barren serpentine hills east of Havana support a characteristic vegetation. The pine woods of Pinar del Rio were investigated in company with Brother Léon and Professor Roig, botanists who have done much to increase our knowledge of Cuban plants Stops were made at two laboratories having facilities for visiting scientists The first called Harvard House, is under the auspices of Harvard University, and is located at Soledad, near Cienfuegos, on a sugar plantation. In connection with Harvard House is a fine botanical garden. The second laboratory is in charge of the Tropical Plant Research Foundation, which has its Cuba division at Baraguá (Province of Camaguey) on a large sugar plantation Through the courtesy of the United Fruit Company Professor Hitchcock was able to visit the Company's plantations at Guaro and Preston (Province of Oriente) and to investigate the pine forests of the Sierra Nipe.

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PETROLOGY. —*An analcite-rich rock from the Deccan traps of India.*[1]

N. L. BOWEN. Geophysical Laboratory, Carnegie Institution of Washington.

In a study of the thin sections of a large collection of specimens of the Deccan traps in the possession of Dr. H. S. Washington a type was noted with a large proportion of a clear isotropic groundmass This has a very low refractive index and is therefore quite distinct from the glassy groundmass occasionally found in some of the ordinary traps. The isotropic substance is, in fact, analcite and in other respects the rock is so unusual that its occurrence seems worthy of note.

The specimen is labelled "Deccan trap N.W. base of Ketool Hill, Cutch, India," and has the general appearance of an ordinary trap. The weathered surface has occasional pits that suggest amygdules but are in reality produced by the weathering out of olivine crystals which show as clear grains on the fresh break and are the only constituent of the rock identifiable in the hand specimen

Under the microscope the rock is found to consist principally of analcite and pyroxene with a fair amount of olivine, as the small phenocrysts already noted, some nephelite, a little biotite, and rather abundant grains of an opaque ore mineral.

The pyroxene occurs as clusters and patches of minute felted prisms, some of which have the appearance of irregular individual grains in ordinary light, the composite character being clearly revealed, however, under crossed nicols. They average about 0.1 mm. in length and not more than ¼ that amount in width. The high extinction angle and high refractive indices (above 1.70) mark it as augite. It probably makes up nearly one-half the rock. Analcite acts as a matrix between the patches and streaks of augite but another mineral is found to be

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[1] Received December 23, 1926.

interstitial to the prisms of augite of the felted mass when they are not too crowded to permit a determination of its presence. It has low refraction but, unlike the analcite, has a definite birefringence. Occasionally, on the border between augite clusters and analcite, definite prismoids of this mineral were observed which had weak birefringence, parallel extinction, negative elongation, and higher index than analcite but much lower than augite. They are in all probability nephelite.

In one thin section a rounded area about 2 mm in diameter was noted in which the mineral constituents are somewhat different from those in the main mass. The mineral determined as probably nephelite is the principal constituent and in it are contained prisms of a pyroxene which, unlike the augite of the main rock, is decidedly green and undoubtedly somewhat acmitic. In addition to this there are grains of a strongly pleochroic deep-brown amphibole. This patch is, on a minute scale, analogous to the blebs of a pegmatitic character often seen in igneous rocks, especially those of an alkaline type.

Of the constituents of the main mass of the rock, again, analcite is perhaps a little less abundant than pyroxene. It occurs as a groundmass to the patches and clusters of augite prisms and its own distribution is therefore correspondingly patchy. It is entirely isotropic in thin section and the refractive index is between 1.485 and 1.495. Acid dissolves the mineral with separation of silica and the solution shows alumina and soda. There is no tendency for analcite to occur as euhedral individual crystals resembling leucite such as are common in analcite basalts. The patches of analcite are, however, granular, the border between grains being ordinarily marked by filaments of some substance of higher index and the shapes of the individuals strongly suggesting the polyhedral outlines appropriate to analcite.

Olivine is present as crystals that sometimes show an approach to euhedral outline but are generally of irregular shape and make up perhaps 10 to 15 per cent of the rock. They may be as much as 2 mm. in diameter and therefore far exceed in size the grains of any other mineral. The refractive index $\gamma = 1.70$ and 2V is nearly 90° so that the olivine must contain approximately 10 per cent FeO. In some grains it is entirely fresh and in others it may be completely transformed to serpentine

Mica occurs in very subordinate amount and its relations to the pyroxene and ore suggest that it has been formed by reaction of the alkalic liquid with these minerals. Its strongest absorption is a pale brown and is in the normal position for biotite.

The ore mineral appears as small grains often of approximately octahedral shape.

Feldspar is entirely absent.

The Deccan traps are a thick series of basaltic lavas of the plateau type.[2] They are normally of ordinary basaltic composition and are made up almost exclusively of augite and plagioclase. The present rock is decidedly different. There is no information regarding its mode of occurrence and therefore no definite assurance that it is a lava, but the extremely fine prisms of augite suggest a rate of cooling that is consistent with such a mode of occurrence.

It is not possible to interpret the rock as an ordinary basalt in which analcite has replaced plagioclase for the augite has neither the granular character produced by extremely rapid chilling nor the ophitic character produced by somewhat less rapid chilling in ordinary basalt. The minute prisms are, indeed, such as appear to be characteristic of alkaline basalts. The presence of nephelite suggests the possibility that the rock was a nephelite basalt now strongly analcitized.

The evidence that analcite takes the place of other minerals, principally nephelite, is not clearly to be made out and is rather suggested than proved by its patchy distribution and the fact that nephelite rather than analcite is the matrix of the pyroxene prisms where they are most closely crowded. Occasionally, however, a seam of analcite is to be seen lying along the imperfect prismatic cleavage of nephelite. On the whole it would appear that the rock is a nephelite basalt which has suffered analcitization, but the possibility that it is an analcite basalt and the analcite dominantly primary can not be excluded.

In either case it is apparently the first example from the Deccan traps of a rock of such strongly alkaline affinities.

I am much indebted to Doctor Washington for the opportunity of examining his collection of these rocks.

BOTANY.—*New* Asteraceae *from Costa Rica.* S. F. BLAKE, Bureau of Plant Industry.[1]

The four new species described in this paper form part of the extensive collections of plants made in Costa Rica in 1924 and 1925–6 by Paul C. Standley of the U. S. National Museum. Notes on certain other species are added.

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[2] H S. WASHINGTON *Deccan Traps and other Plateau Basalts.* Bull Geol. Soc. Amer, 33: 765–803. 1922

[1] Received December 23, 1926.

Archibaccharis irazuensis Blake

Hemibaccharis irazuensis Blake, Contr. U. S. Nat. Herb. **20**: 551. 1924.

Dr Johann Mattfeld of Berlin has called my attention to the fact that in describing the genus *Hemibaccharis*[2] I overlooked Heering's genus *Archibaccharis*,[3] founded on *Baccharis hieraciifolia* Hemsl. and *B hirtella* DC. Of the 15 species recognized in my treatment, several have already been transferred to *Archibaccharis* in Standley's "Trees and Shrubs of Mexico" The six following species (all Mexican or Guatemalan) require transfer.

Archibaccharis corymbosa (Donn. Smith) Blake

Diplostephium corymbosum Donn Smith, Bot. Gaz. **23**: 8. 1897.
Hemibaccharis corymbosa Blake, Contr. U. S. Nat. Herb. **20**: 553. 1924.

Archibaccharis flexilis Blake

Hemibaccharis flexilis Blake, Contr. U. S. Nat. Herb **20**: 549. 1924.

Archibaccharis glandulosa (Greenm.) Blake

Baccharis glandulosa Greenm Proc. Amer. Acad. **40**: 36 1904.
Hemibaccharis glandulosa Blake, Contr. U S Nat. Herb **20**: 546. 1924.

Archibaccharis hieracioides Blake

Baccharis hieraciifolia Hemsl Biol. Centr. Amer. Bot. **2**: 129. 1881. Not *B. hieracifolia* Lam 1783
Archibaccharis hieraciifolia Heer Jahrb Hamb. Wiss Anst **21**: Beiheft 3: 40. 1904, as to synonym only.
Hemibaccharis hieracioides Blake, Contr. U. S Nat Herb **20**: 547. 1924.

Heering's treatment of this species is far from clear. Although he published the name as "*A. hieraciifolia* Heering n. spec." and cited Hemsley's synonym with a mark of interrogation, he apparently did not consider the plant referred to (*Pringle* 6257) a new species, for he gave no diagnosis, merely remarking that Hemsley's description called for leaves attenuate at both ends and petioled or subsessile, while in his plant they were sessile and auriculate. *Pringle* 6257 is in fact the type number of *Baccharis glandulosa* Greenm (1904), a species distinct from *B. hieraciifolia* Hemsl In the case of his second numbered species, Heering was similarly ambiguous, listing it as "*A. hirtella* Heering n spec," but citing "*B. hirtella* DC. . . . ex descr." and "*B. hirtella* Klatt! Leopoldina XX. (1884), p. 4" among the synonyms. On the whole, it seems advisable to treat these two names of Heering as representing new combinations rather than new species. A third species, *Archibaccharis schultzii* Heer. (l c. 41), based on *Liebmann* 425, is mentioned by Heering with a few words of description quite insufficient to permit the recognition of the species in the absence of specimens.

Baccharis hieraciifolia Hemsl. was based on *Bourgeau* 951 and 1230, both from Desierto Viejo, Valley of Mexico Both numbers, as represented in the

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[2] Contr U S Nat Herb **20**. 544 1924

[3] Jahrb Hamb Wiss Anst **21**: Beiheft **3**: 40 1904

Kew Herbarium, belong to the species with naked petioles, *Archibaccharis hieracioides*. The specimen of *Bourgeau* 1230 in the U. S. National Herbarium, however, is *A. glandulosa* (Greenm.) Blake, with amplexicaul-based leaves.

Archibaccharis salmeoides Blake

Hemibaccharis salmeoides Blake, Contr. U. S. Nat. Herb. **20**: 548. *pl. 50.* 1924.

Archibaccharis simplex Blake

Hemibaccharis simplex Blake, Contr. U. S. Nat. Herb. **20**: 547. *pl. 49.* 1924.

Gnaphalium rhodarum Blake, sp. nov.

Annual, leafy; stem lanate-tomentose and stipitate-glandular, leaves lanceolate, acuminate, green and glandular above, arachnoid-tomentose beneath, short-decurrent, heads rosy, medium-sized, in close glomerules crowded in a small panicle.

Single-stemmed, 24–30 cm. high or more, erect, the stem or the few branches simple below the inflorescence, lanate-tomentose with whitish wool, densely so toward apex, toward base glabrescent, exposing the dense stipitate glands, leaves nearly uniform, 2.5–5 cm. long, 4–8 mm. wide, with attenuate dark callous tips, broadest toward base and decurrent in rather broad wings 3–8 mm. long, repand, very narrowly revolute-margined, heads campanulate-subglobose, about 4 mm. high and thick, glomerate at tips of the usually few and short branches of the panicle, the glomerules 1–1.8 cm. thick, pistillate flowers 37, hermaphrodite 10; involucre 4 mm. high, about 3-seriate, somewhat graduate, the phyllaries broadly ovate to oblong, obtuse or slightly apiculate, somewhat erose, the concealed green base arachnoid, the tips bright rosy or becoming light brown in age, corollas whitish, achenes oval-oblong, plump, 0.7 mm. long, papillose, otherwise glabrous, pappus bristles white, deciduous separately, not thickened above.

COSTA RICA: In paramo, Cerro de las Vueltas, Province of San José, alt. 2700–3000 meters, 29 Dec. 1925–1 Jan. 1926, *Standley & Valerio* 43623 (type no. 1,253,330, U. S. Nat. Herb.), in open forest, same data, *Standley & Valerio* 43961; Cerro de Buena Vista, alt. 3100 meters, 19 Jan. 1891, *Pittier* 3433.

Pittier's plant was determined by Klatt as *Gnaphalium roseum* H. B. K., to which *G. rhodarum* is related. In *G. roseum*, however, the leaves are persistently tomentose above and much less conspicuously decurrent.

The specific name is Latinized from '*ροδαρὸς*,' *rosy*, a word given in Schrevelius' Lexicon but not in Liddell and Scott.

Gnaphalium subsericeum Blake, sp. nov.

Low herb, stem simple, white-lanate-tomentose, leaves rather few, linear, attenuate, green above, closely subsericeous-tomentose with white hairs beneath, not decurrent, heads small, numerous in a small dense cymose panicle, phyllaries narrow, blackish green below the obtusish firm white tips, corollas reddish-purple above.

Stems 11–16 cm. high, erect, solitary (or paired?) from an apparently perennial slender root, densely and subsericeously lanate-tomentose; leaves nearly uniform (the upper only slightly shorter), about 12 above base of stem, 3.5–6 cm. long, 3–5 mm. wide, attenuate to a callous brownish tip, sessile, not narrowed at base, entire, firm, above deep green, glabrescent or glabrate, very narrowly revolute-margined, the narrow green costa evident beneath; heads campanulate, 4 mm. high, 2.8 mm. thick, glomerate on the very short branches, forming a very dense rounded panicle 3–3.5 cm. thick; pistillate flowers 69, hermaphrodite 8; involucre 4 mm. high, about 5-seriate, rather strongly graduate, the outer phyllaries ovate, obtuse, the inner linear, obtuse or acutish, all with narrow greenish midline below, bordered by whitish, then by a narrow line of shining yellow brown, blackish or greenish black below the white chartaceous apex, thinly arachnoid below; achenes angled, 0.6 mm. long, nearly glabrous; pappus bristles apparently deciduous in groups, those of the hermaphrodite flowers slightly stouter than the pistillate, but not clavate-thickened.

COSTA RICA: Wet meadow, La Palma, Province of San José, alt. 1600 meters, 3 Feb. 1924, *Standley* 32941 (type no. 1,226,057, U. S. Nat. Herb.).

Evidently related to *Gnaphalium salicifolium* (Bertol.) Sch. Bip. (*G. rhodanthum* Sch. Bip.), which ranges from Mexico to Guatemala. In *Gnaphalium salicifolium* the stem is distinctly indurate below or even suffrutescent, and densely leafy, the leaves are less attenuate, persistently tomentose above and not subsericeous beneath, the heads distinctly larger, and the phyllaries usually purple-tinged.

RENSONIA SALVADORICA Blake, Journ. Washington Acad. Sci. 13: 145. 1923. Fig. 1.

This species, the only representative of its genus, was described from three collections made by Mr. Standley in the Department of Ahuachapán, Salvador, in January 1922. The original material was in mature fruit, and did not show the character of the ray corollas. The description of the genus can now be completed from further material of the same species collected in January 1926 at five different localities in the Cordillera of Tilarán, Province of Guanacaste, Costa Rica, at 500–700 meters altitude, by Paul C. Standley and Juvenal Valerio (nos. 44224, 45572, 45828, 46083, and 46455). The specimens are described as collected from erect or ascending, usually subscandent, rarely epiphytic shrubs 1–4.5 m. high, common in moist or dry forest. The following characters should be added to the generic description:

Corollas all yellow, rays 8, fertile, 1-seriate, spreading, about equaling the disk (tube hispidulous above, 1.3 mm. long, lamina oval-oblong, shallowly or rather deeply 2-lobed, with one of the lobes sometimes bidentate, 3.8–5 mm. long, 2.5 mm. wide, hispidulous on back chiefly on the nerves, 8–9-nerved, 2 of the nerves much stronger than the others); ray achenes usually with a pappus of a single stout hispidulous awn or tooth (0.8 mm. long or less) on the inner side; pappus of disk achenes a short, thick, hispidulous-ciliolate crown, usually prolonged into 1–3 unequal teeth or short awns 1.2 mm. long or less.

Hieracium sphagnicola Blake, sp. nov.

Section *Crepidisperma*, phyllopodous, basal leaves oblanceolate, up to 17 cm. long, thin, sparsely long-pilose, stem rather tall, bearing 0–2 elongate leaves below the middle, sparsely long-pilose below, loosely cymose-branched above bearing 5–8 heads on elongate, flexuous, flocculent, finely glandular, and apically pilose peduncles; involucre narrowly campanulate, 8–11 mm. high, stipitate-glandular and sparsely pilose, chiefly toward base; achenes

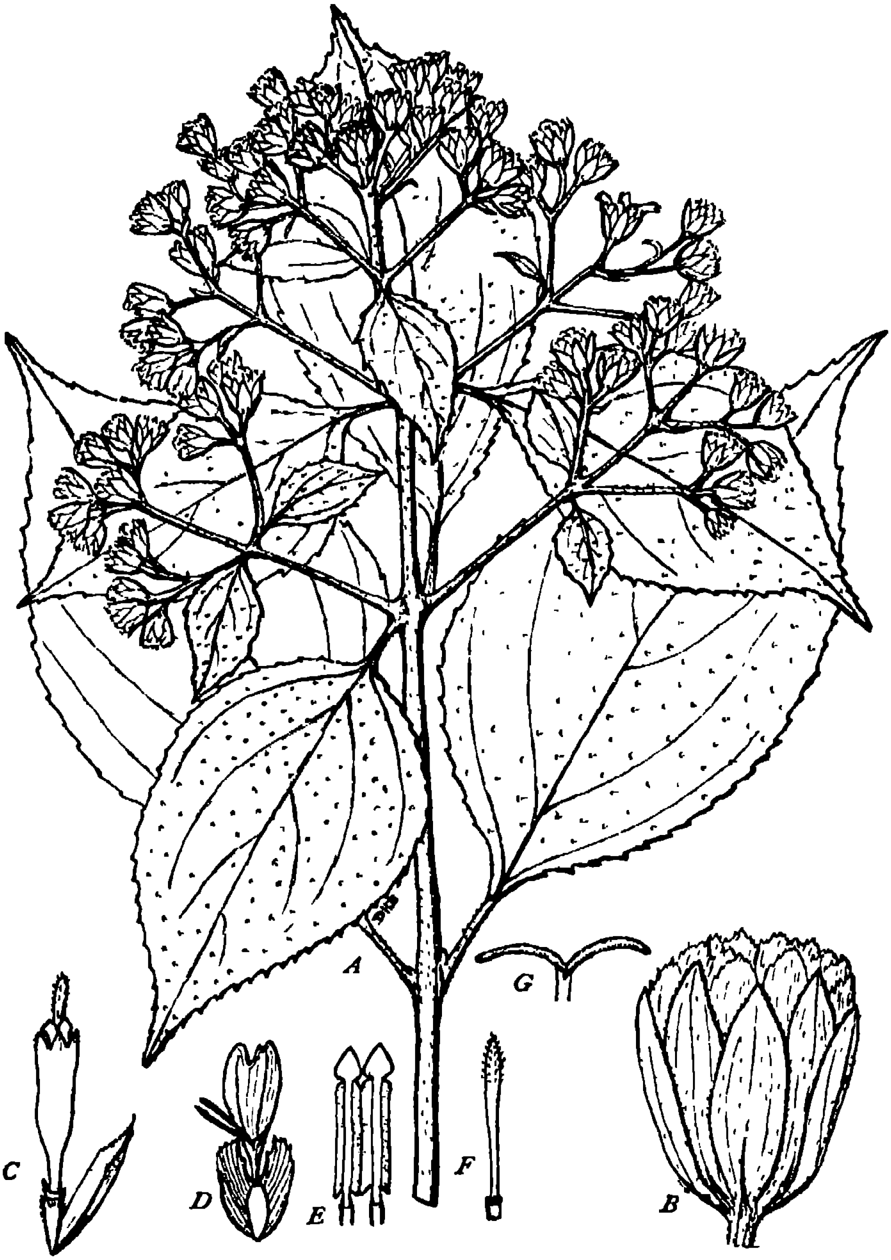

Fig. 1. *Rensonia salvadorica* Blake (drawn from *Standley & Valerio* 45572) —*A*, portion of plant, ×1; *B*, fruiting head, ×6; *C*, disk floret and pale, ×5, *D*, ray floret, ×4; *E*, stamens, ×10; *F*, style and nectary of disk floret, ×10; *G*, style branches of ray floret, ×10.

distinctly tapering above or nearly columnar, 3–4 mm. long; pappus brownish, 5 mm. long.

Plants apparently tufted, 35–85 cm high, from slender, vertical (?) rootstocks, basal leaves oblanceolate or obovate, 7–17 cm long (including the slender petiole, this 1.5–9 cm long), 8–18 mm wide, obtuse or rounded, bluntly callous-apiculate, tapering at base, remotely denticulate (teeth dark, glandular-callous, up to 0.5 mm. long), green on both sides, above sparsely pilose, especially toward margin, with brownish hairs (these minutely hispidulous, about 3 mm long, with darker brown, somewhat pustulate base), beneath similarly pilose chiefly along costa, the petioles more densely pilose; stem leaves similar to the basal but narrower, 6–11.5 cm. long, 3–7 mm. wide, densely pilose-ciliate at base; stems 1–2 together, very slender, branching above or sometimes from near base, below pilose with loosely reflexed hairs like those of the leaves, practically glabrous near middle, above sordid-flocculent and finely stipitate-glandular with short, several-celled hairs; bracts subtending the upper peduncles small and narrow or minute, peduncles monocephalous, 1.5–5.5 cm. long, flexuous and often divaricate, the glands blackish below, yellowish above, the longer hairs blackish, involucre somewhat graduate, the phyllaries blackish green, lance-oblong or the outer lanceolate, obtuse to subacuminate (the inner 1–1.3 mm. wide), the glandular hairs yellowish-tipped, blackish below, flowers about 23, their corollas yellow, 14 mm. long (lamina 9 mm.), deeply 5-toothed (teeth 3.5–4.5 mm long), the teeth essentially glabrous, achenes brownish black or purple brown, short-tapering at base; styles pale.

COSTA RICA: Common in open sphagnum bog, Laguna de la Chonta, northeast of Santa María de Dota, Province of San José, alt. 2000–2100 meters, 18 Dec. 1925, *Standley* 42139 (type no. 1,252,630, U. S. Nat. Herb.). Also collected at same place and date under no. 42343.

Readily distinguished from *H. irasuense* Benth., *H. standleyi* Blake, and *H. abscissum* Less., the only other species known from Costa Rica, by its foliage and pubescence.

Hieracium standleyi Blake, sp. nov.

Section *Crepidisperma*, phyllopodous, eriopodous, basal leaves small, sparsely long-pilose, stem scapose, short, bearing linear bracts at base of peduncles, otherwise naked, glabrous below; peduncles 3, long, monocephalous, above flocculose, finely glandular, and sparsely pilose; involucre rather broad, 9–11 mm. high, the phyllaries lanceolate to oblong, obtuse to acutish, broad (the inner 1.5–2 mm. wide), pilose at base and along midline, not glandular; achenes obscurely tapering above, 2.5–3.8 mm. long; pappus brownish, 4.5 mm. long.

Perennial, 1-stemmed, 17 cm high, from a short praemorse rootstock with elongate slender rootlets, pilose-tufted at base with somewhat rusty hairs, basal leaves about 6, obovate, 3.5–4 cm. long (including the petioliform base, this about 1 cm long), 1 cm. wide, rounded, bluntly callous-apiculate, tapering at base, obscurely and bluntly callous-denticulate, firm, above light green, sparsely pilose (hairs 1.5–3 mm long, whitish, with small dark pustulate base, minutely hispidulous but not obviously many-celled), beneath pale green, sparsely long-pilose chiefly along costa and the 4–5 pairs of lateral veins, scape 3-headed, the unbranched portion 1.8 cm long, practically glabrous, the lowest peduncle 13.5 cm long, 1-headed and with an abortive lateral head, subtended by a linear-spatulate bract 2 cm long and 1 mm wide, sparsely pilosulous below, above loosely flocculose and densely short-glandular with small, blackish-based, many-celled, yellowish glands, toward the head also loosely pilose with blackish-based hairs, the 2 other peduncles about 7.5 cm. long, involucre campanulate, 7–10 mm. thick (as pressed), rather strongly graduate, the outermost phyllaries lance-triangular, 2–4 mm. long, obtuse, blackish-green, pilose at base and along midline (the hairs blackish below, whitish above), the inner phyllaries about 13, narrowly oblong, obtuse, or acutish, thinner and paler above, with black, sparsely pilose midline; corollas "bright yellow," about 10 mm. long (lamina 7 mm. long), with 5 glabrous teeth (1.3–1.8 mm. long), achenes deep purple-brown, styles blackish-green.

COSTA RICA: Scarce, in paramo, Cerro de las Vueltas, Province of San José, alt. 2700–3000 meters, 29 Dec. 1925–1 Jan. 1926, *Standley & Valerio* 43624 (type no. 1,253,331, U. S. Nat. Herb.).

This species, represented by a single specimen, is apparently nearest the Mexican *Hieracium junceum* Fries, but is abundantly distant in involucral characters from that species as described in Zahn's monograph.

BOTANY.—*Fourteen new species of plants from Hispaniola.*[1] E. C. LEONARD, U. S. National Museum. (Communicated by PAUL C. STANDLEY.)

The fourteen species of flowering plants here described from the island of Hispaniolá belong to several families, and all but three are based upon material collected by the writer in the course of his visit to the mountains of northern Haiti during the winter of 1925–26. Of the two exceptions, one is a *Brunfelsia* found by Dr. W. L. Abbott on the Samaná Peninsula, Dominican Republic, and the other two are new grasses from Furcy, southern Haiti, described by Agnes Chase from specimens obtained by the writer on a visit to that region in company with Dr. Abbott, in 1920.

Phthirusa siegeri Leonard, sp. nov.

Stems branched, erect or ascending, 20 to 50 cm. high, glabrous, the upper internodes compressed narrowly winged, broadened at the nodes, the lower internodes terete, light gray, leaves firm, leathery, oblong-obovate or oblong-elliptic, 4 to 7.5 cm. long, 1.5 to 3 cm. broad, rounded or obtusish and apiculate at apex, gradually or somewhat abruptly narrowed to a short (2 to 5 mm. long) petiole, glabrous on both surfaces, drying olive-green, the midrib on lower surface and the petiole sharply triangular in cross-section, the lateral veins 3 or 4 pairs, inconspicuous in younger leaves, flowers 2 to 4 in racemes 1.5 to 3 cm. long, in the axils of the upper leaves, the rachis light gray-furfuraceous, flattened, broadened at the insertion of the pedicels, pedicels 1 to 2 mm. long, gray-furfuraceous, cupule shallow, about 2 mm. long, 4 mm. broad, gray-furfuraceous, obscurely lobed, the lobes deltoid, obtuse, calyx minute, entire; petals 6, yellowish without, reddish within, thick, linear-oblong, 2 to 5 mm. long, 0.75 mm. broad at base, gradually narrowed from middle to an acute tip; stamens 6, attached to the petals about 1 mm. above their base, the 3 sterile ones 1.5 mm. long, excavate on the margins below the triangular sterile anther (this 0.75 mm. broad), the 3 fertile stamens 1 mm. long, their anthers oval, apiculate, about 0.05 mm. broad; style fusiform, scarcely 2 mm. long; berry oval, black, 1 cm. long, 6 mm. broad, minutely reticulate.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received December 20, 1926

Type in the U. S. National Herbarium, no. 1,149,122, collected from a tree on a dry plain east of the Atalaye Plantation, vicinity of St. Michel, Département du Nord, Haiti, altitude 350 meters, November 18, 1925, by E. C. Leonard (no. 7166).

Additional specimens examined:

HAITI: Mt. La Mine, vicinity of St. Michel, November 19, 1925, *Leonard* 7227. Dry bank along the Puilboreau road, north of Ennery, Département de l'Artibonite, altitude 400 meters, January 17, 1926, on *Poitea multiflora* (Sw.) Urb., *Leonard* 8903, February 13, 1926, *Leonard* 9715. Dry thickets on mountain slope southeast of Ennery, January 19, 1926, *Leonard* 8971.

Phthirusa siegeri is easily distinguished by the short, stout, few-flowered, light gray-furfuraceous racemes, large black oval berries, and small yellowish flowers. The species is named for Mr. E. J. Sieger, manager of the United West Indies Corporation, who assisted me greatly in my work at St. Michel.

Coccoloba revoluta Leonard, sp. nov.

Small tree with numerous spreading branches, bark light gray, young twigs puberulent, striate, slightly swollen at the nodes, the internodes 1 to 2.5 cm. long, ocreae 5 mm. long, obliquely 2-lobed at tip, the lobes short, obtuse; petioles 3 to 4 mm. long, 2 mm. broad at base, flat, puberulent above, glabrous beneath; leaves ovate, 2 to 4.5 cm. long, 1.5 to 3 cm. broad, rounded or obtuse at apex, subcordate at base, firm, revolute, drying olive-green, glabrous and prominently but minutely reticulate on both surfaces, the principal nerves 4 to 5 pairs, obscure above, prominent beneath; flowers and fruit not seen.

Type in the U. S. National Herbarium, no. 1,149,188, collected in a dry thicket several miles north of the Atalaye Plantation, vicinity of St. Michel, Département du Nord, Haiti, altitude 350 meters, December 26, 1925, by E. C. Leonard (no. 8499). No. 7244, collected November 20, 1925, at the same locality is of this species.

In shape and texture of leaf blades this species closely resembles *C. pilonis* Urb. and *C. krugii* Lindau, but in neither of these species is the upper surface of the leaf blades prominently reticulated, and both have longer and more slender petioles.

Coccoloba fulgens Leonard, sp. nov.

Small tree 3 to 6 meters high, stems, leaves, and inflorescence glabrous, twigs reddish brown, ocreae 5 to 8 mm. long, oblique at tip, soon deciduous; petioles 2 to 10 mm. long, leaf blades oblong-elliptic to obovate, 2 to 5 cm. long, 15 to 25 cm. broad, round at apex, narrowed from middle to petiole, acutish or obtuse at base, entire, firm, shining, yellowish green when dry, both surfaces coarsely and prominently reticulate, the lower surface minutely glandular-punctate, the principal lateral veins 4 or 5 pairs; racemes solitary, terminal on small branches, 2 to 3 cm. long, the fruits 20 to 35, somewhat crowded; ocreolae 0.75 mm. long; flowers not seen; pedicels 1 mm. long, fruit reddish brown, pyriform, 6 mm. long, 4 mm. thick, the accrescent sepals closed over fruit, triangular, blunt, about 2.5 mm. long.

Type in the U. S. National Herbarium, no. 1,300, 397, collected in a thicket on the Puilboreau Pass between Ennery and Plaisance, Département de l'Artibonite, Haiti, altitude 900 meters, January 23, 1926, by E. C. Leonard (no. 9145).

In fruit and shape of leaf blades this plant resembles *C. obtusifolia* Jacq but that species has puberulent stems and petioles, a longer and more slender rachis, and larger leaves

Aeschynomene aurea Leonard, sp nov.

Herbaceous, branched at base, the branches slender, erect or ascending, leafy to the summit, striate, sparingly and minutely strigose with white hairs, or the hairs on the tips of the branches spreading, stipules sessile, ovate or lanceolate, rounded at base, acute or acuminate, prominently nerved, sparsely strigillose or glabrous, leaves 1.5 to 3 cm long, hispidulous with white hairs, the petioles 3 to 4 mm long, the petiolules 0 5 mm long, the leaflets 6 to 11 pairs, 5 to 6 mm long, 2 to 2 5 mm wide, oblique and subcordate at base, oblique and obtuse at apex, prominently reticulate-veined beneath; flowers few, in axillary or terminal racemes up to 3 cm long, pedicels 5 to 10 mm long, pubescent with white, appressed or spreading hairs, bracts ovate, 1 5 mm long, acutish, prominently parallel-veined, calyx 4 mm long, sparsely strigillose. 2-lipped, the 2 lower lobes obtuse, the 3 upper ones triangular and acuminate, corolla golden yellow, the standard ovate to suborbicular, about 9 mm long, 8 mm broad, more or less pubescent without, the claw cuneate, 2 mm long, 2 mm broad above, the wings obliquely obovate, as long as the standard, the claw slender, the keel curved, obliquely truncate, about 5 mm long, stamens diadelphous, the united portion of the filaments 4 5 mm. long, the free portion 1 5 to 2 mm long, ovary stipitate, 5 mm. long, minutely pubescent, style about 4 mm long, abruptly bent, glabrous above, pubescent below; pods 2 to 2 5 cm long, flat, 3 to 5-jointed, reticulate, appressed-pubescent, deeply constricted below, the tip hair-like, about 5 mm. long.

Type in the U S National Herbarium, no 1,300,172, collected on the Puilboreau road above Ennery, Département de l'Artibonite, Haiti, altitude 800 meters, January 13, 1926, by E. C. Leonard (no 8818)

Aeschynomene aurea is closely related to *A. tenuis* Griseb , a Cuban species, but the two plants differ strikingly in several respects The stems of *A tenuis* are glabrous and bear but few leaves which are mostly near the base, the leaflets are narrower, the flowers smaller, and the pods glabrous or but very sparsely strigillose, very obscurely reticulate, and thick-margined The stems of *A. aurea* are strigose and leafy to the summit and the pods are appressed-puberulent, prominently reticulate, and not thick-margined.

Galactia retrorsa Leonard, sp. nov

Twining vine, stem retrorsely pilose with yellowish hairs about 0 5 mm. long; stipules retrorsely pilose, 3 to 4 mm. long, petioles 2 to 6 cm. long, retrorsely pilose; leaflets 3; petiolules pilose with yellowish, appressed or ascending hairs, those of the lateral leaflets 1 to 2 mm. long, those of the terminal one 5 to 10 mm. long; leaf blades oblong-elliptic, rounded at both ends, firm, entire, the upper surface with a few hairs on the mid-rib, the lower surface velvety-appressed-pilose, the hairs on midrib denser and yellowish, the veins reticulate but not prominent, flowers numerous, in axillary racemes reaching 6 cm. in length; peduncles very short or none, the pedicels slender, 2 to 3 mm. long, pilose with minute, whitish, spreading, retrorse or appressed hairs; calyx slightly 2-lipped, about 5 mm. long, minutely appressed-pilose or a few of the hairs ascending, the lobes 1.5 mm. long, triangular, with an awnlike tip, corolla bright purple, about 8 mm. long, the standard orbicular, 5 mm. broad, emarginate, the claw 3.5 mm. long, 1.5 mm. broad, narrowed to 0.5 mm. at base, the wings obovate, 5 mm. long, 2 mm. broad, the keel curved, rounded, emarginate, about 3 mm. long; stamens diadelphous, the tube and single stamen 5.5 mm. long, the free portion of the 9 united stamens 0.5 mm. long, the stamen tube narrowed above; stigma 3 mm. long, appressed-pubescent.

Type in the U. S. National Herbarium, no. 1,149,590, collected on hillside near small stream on the north slope of Mt. Platanna, in the vicinity of St. Michel, Haiti, altitude about 350 meters, December 7, 1925, by E. C. Leonard (no. 7811). No. 8119, collected in the vicinity of Marmelade, and no. 9228 from Plaisance, are to be referred to this species. They were taken from fruiting plants and differ from the type in their relatively shorter leaf blades and more sparsely pubescent stems. The pods are 2.5 to 3 cm. long, 5 mm. broad, slightly curved, abruptly narrowed at the apex to a short curved tip, and appressed-pilose with minute yellowish hairs. The seeds are dark greenish brown or black, flat, 3.5 mm. long and 2 to 2.5 mm. broad.

This well-marked species is characterized by the large rounded-elliptic leaflets, densely flowered, sessile racemes, and yellowish retrorse pubescence of stem and petiole.

Trichilia truncata Leonard, sp. nov.

Shrub or small tree 1 to 3 meters high, young twigs puberulent, the older twigs glabrous or sparingly puberulent, the lenticels round, about 0.5 mm. in diameter, prominent, leaves odd-pinnate, rachis 2 to 6 cm. long, puberulent, petiolules thick, 1 to 2 mm. long, leaflets 3 or 5, subopposite, 4 to 11 cm. long, 2 to 5 cm. broad, firm, leathery, drying bright green, extremely variable, cuneate or narrowly obovate, broadest above the middle, gradually narrowed from the broadest portion to the base, the margins straight or curved, entire, truncate and 3-lobed at apex, or, if narrowed, undulate or coarsely toothed, the apex and teeth or lobes blunt, the upper surface glabrous, the midrib impressed, the lower surface with prominent puberulent midrib and veins, the principal lateral veins 5 to 11 pairs, the secondary ones reticulate, flowers racemose, terminal, in the axils of the upper leaves, the racemes small, about 1 cm. long, the branches puberulent, pedicels 1 mm. long, puberulent, lobes of the calyx triangular, acute, pubescent; flowers not seen, fruit obovoid, 7 to 10 mm. long, velvety-pubescent.

Type in the U. S. National Herbarium, no. 1,300,370, collected along the Puilboreau road, vicinity of Ennery, Haiti, altitude 900 meters, January 21, 1926, by E. C. Leonard (no. 9095). Additional specimens were collected near Marmelade, altitude 800 meters, December 20, 1925 (*Leonard* 8275 and 8288). No. 8288 consists of seedlings about 30 cm. high with both juvenile and mature leaves. The juvenile leaves are linear, 8 to 18 cm. long, 0.3 to 1 cm. wide, and blunt at apex.

This strange plant is found in thickets on the broken lime-capped summits of the higher mountain ranges of northern Haiti. It is probably related to *T. pallida* Sw., which it closely resembles in all respects except in the peculiar cuneate, truncate or lobed leaves. *T. cuneifolia* Urb., a species found in the Dominican Republic, has this type of leaf but the lobes are tipped with prominent spines.

Croton ekmanii Leonard, sp. nov.

Monoecious aromatic shrub about 1 meter high, branches slender, young twigs minutely stellate-pubescent and pilose (each long hair a prolonged ray of one of the stellate hairs), older twigs smooth, gray, petioles very slender, 1 to 3 cm. long, rather sparingly pilose and stellate-pubescent, leaf blades ovate, 2 to 5 cm. long, 1.5 to 2.5 cm. broad (those of the short axillary branches much smaller), obtusish and apiculate at apex, rounded or subcordate at base with a very narrow sinus, thin, entire or undulate, the upper surface dull green, sparingly stellate-pubescent, becoming papillose and subscabrous on loss of the pubescence, the veins obscure, the lower surface grayish green, pilose and stellate-pubescent, the long hairs predominating on the younger leaves, the 4 to 6 lateral veins and midrib rather prominent, glands 1 or 2 pairs on the petiole at base of leaf blade, slender, hair-like, 1 to 1.5 mm. long, flowers few, in small axillary racemes up to 1 cm. long, pistillate flower solitary, the pedicel 1.5 mm. long, pilose and stellate-pubescent, the sepals triangular, 1.5 mm. long, 0.5 mm. broad at base, the styles branched, clawed at tip, bearing several white stellate scales, capsule (immature) densely white-stellate-pubescent, staminate flowers 4 to 6, subsessile on a slender rachis, sparingly pilose and stellate-pubescent, the sepals ovate-lanceolate, slightly falcate, 1.25 mm. long, 0.75 mm. broad, acutish at apex, the petals obovate, pilose at base, shorter than the sepals, stamens 16 to 20, the filaments glabrous, the anthers, oval, about 0.5 mm. long, mature fruit not seen.

Type in the U. S. National Herbarium, no. 1,301,545, collected along stream on the Atalaye Plantation, vicinity of St. Michel, Département du Nord, Haiti, November 17, 1925, by E. C. Leonard (no. 7030).

This species is readily distinguished by its thin ovate leaves, slender petioles with hairlike glands, and by the two types of pubescence.

Thouinia milleri Leonard, sp. nov.

Shrub or small tree reaching 4 meters in height, bark smooth, reddish brown, the lenticels prominent; young twigs appressed-puberulent; petioles 1.5 to 3 mm. long, glabrous, leaflets 3, petiolules 1 mm. long, lateral leaflets oblong-ovate or oblong to linear-lanceolate, 2 to 10 cm. long, 1 to 1.5 cm. broad, the terminal leaflet linear-lanceolate, 10 to 25 cm. long, 1.5 to 2.2 cm. broad, all obtuse and apiculate at apex, narrowed at base, firm, serrate, the teeth low, tipped by the excurrent lateral veins, glabrous above, puberulent beneath, the midrib and lateral veins prominent on lower surface, the lateral veins numerous, parallel, widespreading, joining the midrib nearly at right angles, the veinlets prominently reticulate; flowers numerous, in crowded, axillary and terminal racemes 3 to 6 cm. long, pedicels slender, 3 to 4 mm. long, puberulent, sepals 4, obovate, ciliate with minute blunt hairs composed of square or oval cells, dissimilar, 2 of the sepals keeled, 1 mm. long, the other 2 concave, 1.75 mm. long, petals white, cuneate, 3 mm. long, the apex truncate, undulate, bearing a pair of small bearded scales on the claw 0.75 mm. above its base, stamens 8, the filaments slender, slightly exceeding the petals; anthers white, oval, 0.5 mm. long; ovary 0.5 mm. long, winged; ovules 2

Type in the U. S. National Herbarium, no. 1,300,595, collected at the base of a cliff along the Gonaives road about 5 miles from Ennery, Département de l'Artibonite, altitude 325 meters, February 3, 1926, by E. C. Leonard (no. 9472). Two additional specimens from Haiti were examined, one collected among rocks at the mouth of the caverns north of St. Michel, December 5, 1925, by Leonard (no 7750); the other near l'Arcahaie, March 10, 1925, by G. S. Miller (no 267) *Miller* 267 is a twig bearing leaves and a raceme of mature fruit. The samaras are greenish, spreading, obovate, the dorsal edge straight, the ventral curved, 2 cm long, 7 mm. broad, somewhat striate, and puberulent. The seeds are obovate, 3 mm long, 2 mm. broad and sparingly puberulent.

T patentinervis Radlk , a Cuban species, is closely related to this plant, but has leaf blades not exceeding 7 cm in length and smaller flowers

Tetrazygia brevicollis Leonard, sp nov.

Round-topped shrub about 2 meters high; bark light gray, smooth, young branches sparingly and minutely stellate-furfuraceous, petioles 3 to 6 mm long, gray-stellate-furfuraceous; leaves often erect, the blades oblong-elliptic, 3 to 5 cm long, 1 to 2 cm. broad, acutish or obtuse at apex and tipped by a blunt mucro 0 5 mm long, rounded at base, firm, entire, revolute, the upper surface shining, the midrib channeled, the lateral veins obscure, the lower surface light gray, densely and smoothly stellate-furfuraceous, 5-nerved, the first pair of nerves slender and near the margin of the leaf blade, joining the midrib at base, the midrib and second pair of nerves prominent, the latter joining the midrib about 2 mm above the base, the lateral nerves numerous, wide-spreading, slender, impressed, flowers 1 or 2 on each of the pair of terminal peduncles, peduncles 13 mm long, slightly flattened, furfuraceous, subtended by the upper pair of leaf blades, pedicels 1 mm. long, calyx rather sparsely white-stellate-furfuraceous, the tube 2 mm long, the lobes triangular, acuminate, 3 5 mm long, spreading, corolla not seen, fruit (immature in specimen examined) oval, 5 mm long, 4 mm. thick, sparsely stellate-furfuraceous, becoming glabrous

Type in the U. S National Herbarium, no. 1,149,939, collected on a dry slope six miles north of the Atalaye Plantation, vicinity of St Michel, Département du Nord, Haiti, altitude 400 meters, December 26, 1925, by E. C. Leonard (no 8461).

This species is very close to *T. longicollis* Urb & Cogn., but differs in having smaller leaves and inflorescence and a much shorter calyx tube. *T. longicollis* is described as having a calyx tube 7 to 8 mm long, panicles 3 to 5 cm. long, and leaves reaching 6 cm in length.

Hyptis congesta Leonard, sp. nov

Herbaceous, about 50 cm. high, stem erect, or ascending at base, simple or sparingly branched, square, the angles rounded, the four sides prominently channeled, finely striate, closely puberulent with white curved hairs, also sparingly pilose above, 4 mm. thick; petioles 1 to 3 cm. long, white-tomentose and pilose, leaf blades oblong-ovate, 2 to 5.5 cm long, 1 to 2.5 cm. broad, cordate at base, gradually narrowed to an acute or acutish apex, both surfaces tomentose, the lower surface whitish and strongly reticulate, coarsely serrate the teeth crenulate, the axils of the leaves with short branches bearing small leaves; floral bracts similar to and intergrading with the stem leaves; flowers in short cymes, the cymes crowded in a terminal spikelike cluster at the summit of the stem; pedicels 1 to 2 mm. long, puberulent, calyx 8 to 9 mm long, 4 mm. broad at throat, 3 mm. at the rounded base, 10-nerved, tomentose, the margin ciliate, the teeth abruptly linear, 2 to 2.5 mm long, involute, pilose; corolla light purple or lavender, pubescent at least above, about 5 mm long, the upper lip obcordate, spreading, the lower lip 3-lobed, the lobes rounded, reflexed; stamens 4, didynamous, the filaments about 1 mm long, pilose, the anthers oval, 1.5 mm. long, style reaching mouth of corolla, the stigma 2-lobed, the lobes spreading, mature nutlets not seen

Type in the U. S. National Herbarium, no. 1,149,437, collected on dry calcareous slopes north of Mt La Cidre, Département du Nord, Haiti, altitude 300 meters, November 30, 1925, by E C Leonard (no. 7594)

This species is well marked by the crowded terminal inflorescence and the white-tomentose reticulate leaves It is probably related to *H pectinata* (L.) Poit

Solanum gonaivense Leonard, sp. nov

Shrub about 2 meters high; branches slender, terete, grayish, stellate-pubescent, spines in pairs at the base of the leaves and branches, 2 to 5 mm long, slender, recurved, glabrous, leaves 1 to several on minute axillary branches, rosulate; petioles 0 5 to 1 mm long, leaf blades oblong or narrowly obovate, 3 to 8 mm. long, 2 to 3 mm. wide, rounded at apex, narrowed or rounded at base, both surfaces stellate-tomentose, entire, the midrib and the 2 or 3 pairs of lateral veins obscure, flowers few, solitary and terminal on the leaf-rosettes, pedicels 1 to 4 mm long, stellate-tomentose, calyx 3 to 4 mm long, stellate-tomentose, the lobes 4, linear-oblong, unequal, 3 to 4 mm long, 1 mm broad, rounded at apex; corolla white, 8 to 9 mm. long, the tube 1 mm long, the lobes 4, narrowly lanceolate, blunt at apex, minutely stellate-pubescent without, glabrous within, stamens 4, attached to corolla tube 0 5 mm. above the base, the anthers linear-lanceolate, 6 to 7 mm long, blunt at apex, subcordate at base, the filaments 0 5 mm. long, style 8 mm long, glabrous, ovary globose, 0 75 mm. in diameter, glabrous, mature fruit not seen.

Type in the U. S. National Herbarium, no 1,301,034, collected in an arid thicket on the Ennery Road about 8 miles northeast of Gonaives, Département de l'Artibonite, February 19, 1926, by E C Leonard (no 10,007).

This plant is closely related to *S microphyllum* (Lam) Dun and may be merely a variety or form of that species It differs chiefly in the much smaller leaves and flowers

Brunfelsia abbottii Leonard, sp nov

Shrub, older stems gray, minutely reticulate, glabrous, papillose, sometimes flaky, the tips pubescent with small curved hairs; petioles about 5 mm long, glabrous or sparingly pubescent with small curved hairs, leaf blades lance-elliptic, 6 to 10 cm. long, 2 to 3 cm. broad, gradually narrowed to base acuminate at apex, both surfaces sparingly pubescent, minutely reticulate above, minutely scurfy (?) beneath, the midrib impressed above, prominent beneath, flower terminal; calyx 1 cm long, glabrous and somewhat scurfy, the lobes oblong, 2.5 mm long, 2 mm broad, obtuse or subtruncate, narrowed slightly at middle; corolla white (?), 8.5 to 9 cm long, the tube slender, about 7 mm broad at throat, gradually narrowed to 3 or 4 mm at base, glabrous without, pubescent within, especially at throat, the limb 3.5 cm. broad, spreading, the lobes rounded, stamens didynamous, the upper pair reaching nearly to the throat, the lower pair about 5 mm shorter, anthers lunate, about 4 mm. long, the filaments attached at center of concave side, style exceeding the lower pair of stamens, stigma 2.5 mm broad, ovary 2 mm long, oval, glabrous.

Type in the U S National Herbarium, no 1,147,362, collected on the upper slopes of Loma Atravezada, base of Punta Cabrón, Samaná Peninsula, Dominican Republic, altitude 300 to 600 meters, December 14, 1923, by W. L Abbott (no 2937). Abbott's 280 collected on the summit of Pilón Azúcar near Samaná, altitude 500 meters, December 18, 1920, belongs to this species This specimen consists of a twig bearing leaves and a single fruit. The leaves are thinner and slightly larger than those of the type. The fruit is almost globular, glabrous, and about 18 mm. in diameter, the pericarp glabrous, shining, and yellow within. The seeds are light brown, 2.5 mm. long, 2 mm broad, round at both ends, oval in cross-section, with a straight and a curved side, and deeply but minutely reticulate

This is a very distinct species which bears but little resemblance to any *Brunfelsia* hitherto described from the West Indies

Calamagrostis leonardi Chase, sp. nov

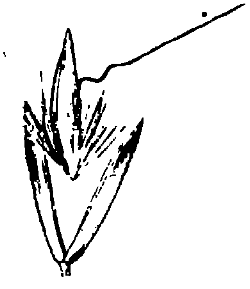

Fig 1 Spikelet of *Calamagrostis leonardi*, × 5 dia

Plant perennial, culms 60 to 100 cm tall, slender, ascending, solitary or few together, compressed, glabrous, nodes dark, glabrous, the lower geniculate, sheaths mostly shorter than the internodes, strongly nerved, the lower minutely retrorsely pubescent, shredded in age, the upper glabrous, ligule hyaline, 3 to 4 mm long, erose, blades lax, flat, 6 to 20 cm long, 2 to 5 mm wide, scabrous, mostly minutely ciliate and in some leaves, sparsely pilose on the upper surface, panicle finally long-exserted, pale, nodding, 12 to 20 cm long, 2 to 4 cm wide, loosely flowered, the slender ascending scabrous branches 2 to 5 cm long, mostly in small fascicles, evenly distributed, spikelets erect on slender scabrous pedicels 2 to 5 mm long, glumes about 4.5 mm long, equal or the first very slightly shorter, abruptly acute, scabrous on the back and keel, the margins thin, both commonly purple-tinged toward the apex, floret nearly equaling the glumes, the callus bearing copious white hairs about half as long as the floret; lemma 4 to 4.2 mm long, scabrous on the back and bearing a slender scabrous awn, flexuous and divergent at maturity, a little above the middle, the margins and apex of the lemma thin, palea about 3.5 mm long, rachilla joint about ⅓ the length of the floret, or slightly longer, long-pilose with white hairs on the outer side and with a few hairs at the summit.

Type in the U S National Herbarium, no 1,076,783, collected on red clay, open mountain top, in the vicinity of Furcy, Haiti, 1300 meters altitude, May 26, 1920, by E. C. Leonard (no. 4325) A second collection was made on Mt. Tranchant, in the vicinity of Furcy, *Leonard* 4370

This species, the only one known from the West Indies, is most nearly related to the South American *C. beyrichiana* Nees, from which it differs in the abruptly acute not attenuate glumes scarcely exceeding the sessile floret (in *C. beyrichiana* the floret is raised on a short curved rachilla-joint), in the more divergent, more flexuous awn, and in the more copious hairs on the prolonged rachilla joint.

Leptochloa monticola Chase, sp nov Plants perennial in dense tough clumps, culms 90 to 100 cm. tall, erect, rigid, simple, scabrous below the slightly constricted glabrous nodes, leaves firm, the sheaths mostly overlapping, minutely ciliate at the truncate summit, otherwise glabrous, the lower somewhat twisted and shredded in age, ligule very minute, almost obsolete; blades 20 to 30 cm long, 2 to 6 mm wide (flattened out) involute, somewhat tortuous and with a very thick midrib, glabrous on the outer surface, scabrous, strongly nerved and obscurely pilose on the inner, pungent-pointed, tapering to a narrow base, the blades bending forward past the culm, bringing the outer surface upward; panicle short-exserted, purplish, about 30 cm long, and 8 cm wide, the common axis stiff, ridged and scabrous, the numerous racemes approximate, those of the middle as much as 10 cm long, the upper and lower shorter, all rather stiffly ascending, spikelets distant about half their own length on the slender scabrous rachis, 8 to 10 mm long, 6 or 7 flowered, the appressed scabrous pedicels 0 5 to 1.5 mm. long; glumes lanceolate-ovate, acute, bronze-tinged with strong scabrous keels and thin margins, the first 2 5 to 3 mm the second 3 5 to 4 mm long, rachilla joints 0 3 to 0 4 mm. long, pilose at the summit, lemmas 4 5 to 5 mm. long, lanceolate-ovate, acuminate, the midnerve slightly exserted from between two minute teeth, densely long-pilose at the base, on the midnerve toward the base, and on the lateral nerves from the base to the middle, palea about 1 mm. shorter than the lemma, concave between the keels, the margins sparsely pilose

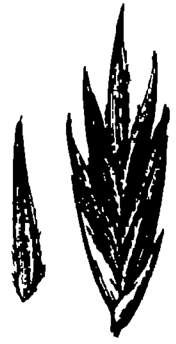

Fig 2 —Spikelet and floret of *Leptochloa monticola*, × 5 dia

Type in the U. S. National Herbarium, no 1,077,272, collected on summit of Pic de Brouet, in the vicinity of Furcy, Haiti, altitude about 1300 meters, June 13, 1920, by E C Leonard (no. 4751), "common on the summit."

This robust species is very different from any known species of *Leptochloa* especially in the forwardly bent involute blades, which are found only in species (like *Ammophila breviligulata* Fern.) of windswept areas

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY

945TH MEETING

The 945th meeting was held in the auditorium of the Cosmos Club on November 13, 1926. The meeting was called to order by President BOWIE at 8.21 with 43 persons in attendance

The program for the evening consisted of two papers, followed by motion pictures of the total solar eclipse of 1926. The first, by W. P. **White** was on *A new method of avoiding trouble from lag in mercury contact thermostats.*

The paper deals with a form of the familiar mercury-contact type of thermostat or temperature-controller In that type the "bulb," which is really a gigantic thermometer, contains a mercury contact which turns a heater off or on, so as always to bring the temperature to the fixed value for which the regulator is set. In all such regulators there is a delay, or lag, in getting the heat from the heater to the bulb, so that the heat is always turned on, or off, a little too late The temperature thus keeps running by the true value, oscillating around that The resulting temperature variations can be minimized by making the oscillations quicker, which makes them also smaller.

In this form of regulator a very fine heater, inclosed within the bulb, provides for very quick oscillations. This heater is connected with the regular bath heater. Whenever heat is turned on it *instantly* raises the temperature of the bulb, which at once shuts the heat off, only to be turned on again as quickly. Exceedingly rapid oscillations are possible, though a period of a few seconds is preferred. This device is generally more convenient in operation than one where the oscillations are produced by mechanical means, since it adds no moving parts It applies the minimum of heat to a very small part of the bulb, hence it avoids most of the temperature uncertainty which results when the oscillations are quickened by causing the main heater to heat the bulb from the outside (*Author's abstract*)

The paper was discussed by Mr **Stimson**.

The second paper by Mr G F. **Taylor**, was entitled *Description of a new type of thermostat* (Illustrated with lantern slides) A new type of thermostat is described in which a spherical piston completely submerged in mercury takes the place of a bare mercury to metal contact. The piston is made of one or more small spheres Each of the spheres is surrounded by a small air space. The surface tension of the mercury as it is forced into the air space exerts a pressure on the piston causing its motion. The piston raises or lowers a magnetized steel weight which makes and breaks electrical contact. The bulb of the thermostat is made of a spiral coil of thin-walled copper tube $\frac{3}{16}$ inch in diameter supported on a frame made of four strips of brass. The piston and contacts are supported in the center of the coil. The bulb is filled with torulene and the piston with mercury. A special valve is provided to keep the mercury and the torulene separate. The torulene will pass freely in either direction through the valve but the mercury will not pass. The instrument may, therefore, be turned in any position without mixing the liquids An overflow cup at the top of the piston which furnishes mercury and keeps the piston submerged is made in a cellular or honeycomb form so that the mercury will not escape even if the cup is inverted The instrument has heavy contacts and may be used without a relay to break a current of about four ampheres.

Experiments were described in which a large number of metals and alloys were tried in order to find one which would carry the greatest current with a minimum of deterioration. Pure radium showed the least deterioration, but electrical contact sometimes failed to accompany mechanical contact. An alloy of 80% radium and 20% platinum was found most satisfactory. A method was described for making disc contacts of this non-malleable material The contacts, which are held tightly together by magnetic attraction, are separated by a spring which causes a sudden and decided break, this, however, at the expense of sensitivity. When very close control is desired, the spring and magnet are not used In this case the interval between make and break was between 20 and 40 microns for the thermostat tested. The thermostat is set to any desired temperature by raising or lowering the pin with its attached piston, using sufficient pressure to force the mercury past the piston. A spherical piston, three millimeters in diameter, and about .001 cm. smaller than the tube in which it fits, will support a pressure of 50 grams and the weight supported appears to be proportional to the number of spheres used. A piston of ten spheres should support 1.5 kg. If more than one sphere is used in making the piston, they are strung on a catgut cord. A somewhat larger piston made of a larger number of spheres would do work sufficient to operate mechanical devices such as steam valves or even doors. A thermo-regulator made on this plan has given very satisfactory service for three years in a cold storage plant. The regulator controls the temperature of the brine tank by starting and stopping the compressers. It is also proposed to operate the pen of a thermograph by using a piston to operate the tracing pen instead of a bimetal of Bordon type. The piston being more sturdy would be less susceptible to vibration and would carry the pen along a straight line instead of a curved line. These instruments are covered by U. S. Public Service Patent No. 1484802, reissue No. 15890. (*Author's abstract.*)

The paper was discussed by Messrs. WHITE and ADAMS.

Following the presentation of the papers, motion pictures of the total solar eclipse of 1926 were shown. This was made possible through the courtesy of Mr. JAMES STOKLEY of Science Service.

946TH MEETING

The 946th meeting was held at the Cosmos Club on Saturday evening, November 27, 1926. The meeting was called to order by President BOWIE at 8·17 with 33 persons in attendance.

The program for the evening consisted of two papers. The first by F. L. MOHLER was on *Spectra excited by atomic hydrogen.* (Illustrated with lantern slides.) Hydrogen from a Wood discharge tube flowed into a tube containing metal vapor and the spectrum emitted by the mixture was photographed. Observations of Bonhoeffer (Zeitschr. f. Phys. chem. **116**. 391, 1925) with sodium and mercury are confirmed. Sodium and cadmium gave strong emission of their first resonance lines and no other lines or bands. Potassium showed the first resonance line faintly. Mercury gave the complete hydride band spectrum and also faint emission of the resonance line at 2537 A. caesium, magnesium thallium and zinc gave no line or band spectra. The excitation energies of the observed lines and bands are, except for 2537 of mercury, less than 3.8 volts, though many lines of lower energy did not appear. There are two possible explanations of the radiation. The metal atom may be excited in a three body collision with two hydrogen atoms. In this case the entire energy of recombination of hydrogen, 4.38 volts, should be available for excitation. The second possibility is that first a hydride is formed and that this reacts with H to form H_2 and an excited metal atom. The available energy of excitation is the energy of recombination of H minus the energy of formation of the hydride. The second theory seems to offer the best explanation of the observations. (*Author's abstract.*)

The subject was discussed by Messrs. BREIT, CURTIS and HAWKESWORTH.

The second paper, by W. G. BROMBACHER was entitled *Discussion of a barometric method of measuring aircraft altitudes.* (Illustrated with lantern slides.) The altitude of aircraft is indicated to the pilot by an aneroid barometer calibrated in altitude according to an altitude-pressure-temperature relation. This is, for the United States, up to 35,332 feet,

$$Z = 63691.8\ T_m \log \frac{(760)}{P}$$

$$T = 288 - 0\ 001982\ Z$$

$$T_m = \frac{0.001982\ Z}{\log_e \left(\dfrac{288}{288 - 0.001982\ Z} \right)}$$

in which Z is the standard altitude in feet; P, the pressure in millimeters of mercury; T and T_m the absolute temperature and absolute mean temperature respectively in degrees Centigrade. The variation in the indication from the altitude due to seasonal changes in air temperature amounts roughly to 5 per cent.

The principal objection to this method of determining altitude lies in the fact that pressure levels are indicated, not the elevation above the surface of the earth. Knowledge of the elevation is important for many purposes, especially for landing when the visibility is poor The indication at the ground level usually varies with time due to both the variation in the barometric pressure and the changing elevation of the ground underneath the aircraft. The barometric pressure at the ground has a variation roughly equivalent to 25 feet per hour change in altitude during the passage of a well defined cyclone If a landing is to be made in such circumstances and if the position of the pointer at 760 millimeters is suitably marked, the following procedure is suggested for obtaining the elevation The landing field personnel, at request, reads the barometer and radios the negative of the corresponding standard altitude to the aircraft The pilot adjusts the altimeter dial so that the 760 millimeter mark and the altitude received by radio correspond. The elevation of the landing field is now indicated by the altimeter.

The performance of altimeters has been greatly improved since 1918, especially the elastic properties The maximum hysteresis (the maximum difference in reading) of good instruments at a given altitude, for decreasing and increasing pressures, has been reduced to one-half This difference at the ground level, known as the after-effect, has been reduced from approximately 200 feet to 50 feet or less

An improvement now in progress is that of compensation for the effect of the seasonal variation in air temperature This compensation may be achieved either automatically or through manual control. The mechanism of an instrument of the automatic type now under construction was shown in order to illustrate the method. Essentially, the mechanism is adjusted by a bimetallic strip or manually so that the multiplication is modified as required by the particular air temperature existing at the time (*Author's abstract*)

The paper was discussed by Messrs. JUDSON, BOWIE, TUCKERMAN and HUMPHREYS.

President BOWIE then called upon Dr TUCKERMAN who spoke informally on the arrangements for the 25th anniversary of the Bureau of Standards, to take place on Dec 4th Following this, President BOWIE spoke briefly on the accuracy now attainable in geodetic work.

H. A. MARMER, *Recording Secretary.*

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VOL. 17 FEBRUARY 19, 1927 No. 4

BOTANY.—Alfaroa, *a new genus of trees of the family Juglandaceae from Costa Rica.* PAUL C. STANDLEY, U. S. National Museum.[1]

In 1924 the writer found in flower in the mountains south of Cartago, Costa Rica, a tree which at the time of collection was supposed to be *Oreomunnea pterocarpa* Oerst., one of the least-known and most remarkable trees of Central America. That tree has had a curious history, and is of interest because of the fact that it has been referred by some botanists to the genus *Engelhardtia*, a group known otherwise from the East Indies.

Later Mr. C. H. Lankester forwarded specimens of the same tree collected at Juan Viñas, in the same general region. Comparison of them with authentic material of *Oreomunnea* proved that they represented a different species. These new specimens were just past the flowering state, and the bracts very small, but it was supposed that they might in age develop into the large hand-shaped bracts that distinguish *Oreomunnea*. The Juan Viñas specimens were given a provisional name as a new species of *Oreomunnea*, but fortunately it was decided to delay publication until more material had been collected. This I was able to do during the present year, when in early March a second visit was made, in company with Prof. Rubén Torres Rojas, to El Muñeco, perhaps the richest locality botanically that I have ever seen. We were fortunate in finding the trees in young fruit. The fruits proved to be a great surprise, for they were not at all like those of *Oreomunnea*, but rather miniature walnuts.

Aside from the superficial aspect of the fruit, the tree did not resemble very closely a walnut tree. Study of the ample series of material now at hand indicates that this Costa Rican tree is best treated as the type of a new genus, which is described here.

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[1] Published with permission of the Secretary of the Smithsonian Institution. Received Dec. 3, 1926.

Alfaroa Standl., gen. nov.

Tree, leaves mostly opposite, estipulate, pinnate, with no truly terminal leaflet, the leaflets numerous, mostly alternate but sometimes opposite, membranaceous, serrate or entire, glandular-punctate beneath, flowers monoecious, spicate, the spikes terminal, the pistillate flowers numerous, inserted singly, sessile, the staminate flowers few, solitary and sessile at the base of the spike or few and arranged upon two short basal branches, bracts of the staminate flowers linear-subulate, shorter than the calyx and free from it, calyx irregularly 4–5-lobed, the lobes oblong, obtuse, stamens about 9, inserted in a single series about the ovoid rudiment of the ovary, the filaments nearly obsolete, the anthers 2-celled, dehiscent by longitudinal slits; pistillate flowers subtended by a minute 3-lobed free bract shorter than the ovary, perianth deeply 4-lobed, the lobes oblong-linear, unequal, obtuse, erect, persistent upon the apex of the fruit, style shorter than the perianth lobes, bifurcate, the stigmas subglobose, verrucose, fruit oval or obovoid, small, the pericarp nearly dry, thin, indehiscent, adhering closely to the endocarp; nut thin-walled, smooth, falsely 4-celled, the partitions nearly complete, seeds 4-lobed to the base

The genus is named in honor of Anastasio Alfaro, Director of the National Museum of Costa Rica, who is remembered with affectionate regard by all scientists who have visited Costa Rica for many years past. His enthusiasm, with regard to all matters relating to natural history has done much to stimulate in others an interest in these subjects In botany his chief interests have been the ferns and orchids, and in the latter, especially, he has made notable discoveries To the National Herbarium he has contributed an extensive series of beautifully prepared specimens of orchids, representing many species of this family of plants, in which Costa Rica is supreme among American countries To Don Anastasio the writer is indebted personally for many courtesies extended during two visits to Costa Rica

Alfaroa costaricensis Standl , sp nov.

Tree 5–12 m high or larger, the small crown composed of few spreading branches, bark nearly smooth, pale brownish, branchlets and leaf rachis usually densely hirsute with long stiff divaricate hairs, sometimes merely velutinous-pubescent or in juvenile plants glabrate, leaves almost all opposite, those of a pair often very unequal, or one of the leaves sometimes suppressed, leaflets usually 10–20, very variable, often almost all opposite, oblong to narrowly lance-oblong, usually 10–18 cm long and 1 5–4 cm wide but often larger, the lowest leaflets of each leaf usually much reduced, acute to long-acuminate at apex, sessile, obtuse to truncate at base and oblique, rarely auriculate on the lower side, densely serrate with apiculate teeth or often entire, membranaceous, above glabrous or nearly so except on the costa, beneath glaucous or glaucescent, usually hirtellous along the nerves and sometimes puberulent between the nerves, but often glabrous or nearly so, flower spikes stout, erect, 3–5 cm. long, short-pedunculate, the rachis densely hirtellous and glandular, the pistillate portion many-flowered (flowers 30–50), dense or interrupted, staminate flowers few, solitary near the base of the spike or 2 to 4 on lateral basal branches less than 1 cm. long; staminate flowers 4 mm.

broad, the perianth glandular; pistillate flowers green, 5–6 mm long, the ovary sparsely hirtellous and densely covered with golden glands, the lobes 1 mm wide, glabrate, the outer surface with a few golden glands, stigmas red, fruiting spikes 12–18 cm long or longer, many-fruited, fruits oval or obovoid, about 2.5 cm long and 2 cm thick, densely velutinous-hirsute and covered with sessile glands, nut smooth, broadly rounded at base and apex, the endocarp less than 1 mm thick.

Type in the U. S. National Herbarium no. 1,226,388, collected in moist forest at El Muñeco, south of Navarro, Province of Cartago, Costa Rica, altitude about 1,400 meters, February 8, 1924, by Paul C. Standley (no. 33620.)

The following additional collections represent the same species:

COSTA RICA: Juan Viñas, alt. 1,260 m., in open pasture, June, 1922, *C. H. Lankester*. La Estrella, Province of Cartago, *Standley* 39217, 39446. Alto de la Estrella, *Standley* 39122. El Muñeco, *Standley* 33501, 33504, *Standley & Torres* 50870, 50874, 50969, 50986, 51078, 51204.

The genus *Alfaroa* is related to *Juglans*, but differs in several important characters. It is unique in the Juglandaceae in having opposite leaves. It is difficult to make a definite decision regarding the arrangement of the leaves, but it is certain that most of them are opposite, and always those on young sterile branches. Occasionally on the older, larger branches there is a single leaf at a node.

In *Juglans* the leaves have a terminal leaflet. In that genus, of course, the nut is rugose, and usually much roughened. I did not notice that the foliage of *Alfaroa* had any odor suggestive of that of walnut leaves, but the glands upon the leaves would suggest the possibility of an aromatic odor.

It is in the inflorescence that the two genera exhibit the greatest divergence. The staminate flowers of *Juglans* are borne in slender drooping catkins; in *Alfaroa* they are borne singly at the base of the erect pistillate spike, or upon two short special lateral branches.

Trees of *Alfaroa* are abundant in the wet mountains south of Cartago, especially at El Muñeco, where they are plentiful among other trees on the tops of the hills. The plants sometimes flower when they are mere shrubs, and the aspect of the mature tree does not suggest a walnut tree. The pale under surface of the leaves is striking, and the young leaves are usually handsomely colored with red and pink. The long spikes of small fruits, recurved by their weight, are borne in great profusion.

For this tree I was given by a guide the name *gaulín*, but this name was disputed by other persons. No use is made of the nuts, apparently. I have not seen the nuts when mature and fresh, and do not know whether they are edible.

ZOOLOGY.—*Five new Chinese squirrels.*[1] A. BRAZIER HOWELL, U. S. National Museum.

Among the Chinese mammals in the United States National Museum are specimens representing five new races of sciuromorph rodents, which may be known as follows:

Eutamias asiaticus umbrosus subsp. nov.

Type.—Male adult, skin and skeleton no 240744, U S. National Museum, from 140 miles south of Lanchowfu, Kansu, China, August 21, 1923. Collected by F R Wulsin, National Geographic Society Central China Expedition, original number 1118

Diagnosis —A dark colored chipmunk differing from *intercessor*, its nearest ally, in the absence of gray hairs throughout the darker areas of the head and shoulders The coloration of the head is darker and duller, and the gray tips to the hairs upon the upper side of the tail practically hide any ochraceous markings

Skin — As above, with the transition between the color of the sides and the buffy whitish of the under parts more abrupt than in *intercessor* The whole anterior half of the dorsum presents a much more saturate appearance, the pelage is longer and there is a more pronounced ochraceous overwash on the two medial light stripes of the middle back The feet are also slightly darker and more ochraceous, this being more pronounced upon the fore feet.

Skull —As in *intercessor* but a bit more slender and bullae smaller, although this difference may not hold good in series, as but one good adult skull is now available

Measurements —Collector's measurements of the type are: head and body, 155, tail, 115, foot, 38, ear, 17 Total length of the skull is 42 mm.

Material — Four specimens two from 120 and 140 miles south of Lanchowfu, and two from Sungpan, Szechwan

Remarks —Although the skins are in summer pelage it is obvious from the coat that it is a more strictly mountainous form than is *intercessor* The Kansu examples are evidently from the north slope of the Minshan Range of mountains, which marks the boundary between that province and Szechwan, while the Sungpan specimens are from just south of this range Whether the race is confined to this circumscribed region is a matter for conjecture

Dremomys rufigenis lentus subsp. nov

Type —Male adult, skin and skull no. 240384, U S. National Museum, from near Wenchuanshein, Szechwan, China, altitude 6000 feet; August 14, 1924 Collected by D. C Graham, original number 14.

Diagnosis —A rather large race, with back, flanks and cheeks uniformly colored Rufous of underparts confined to chin and upper lips, anal region, and faintly along the inner margin of the hind legs. Postauricular spots buffy.

Skin —With the exception of the postauricular spots, which are rather well defined, the whole upper surface, including feet, flanks, head and cheeks, are uniformly colored, the paler annulations of the hairs being more olivaceous than brown The tail as usual is darker because of the greater preponderance

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[1] Received January 19, 1927

of black upon the hairs. Below the rufous areas are rather sharply confined to a narrow space a couple of millimeters wide along the upper lips and upon the chin, and in the anal region, almost exclusively upon the base of the tail, but a narrow border of this color extends along the inner side of the hind leg. The throat, chest and belly are overwashed with gray showing a faint suggestion of buffiness. The under side of the tail is paler than the upper only because there is less black distad upon the hairs.

Skull.—The right zygoma is broken and the occipital and bullae are missing. On the whole the skull resembles that of *belfieldi*, but the anterolateral parts of the nasals extend farther ventrad, the premaxillae extend a marked distance farther caudad beyond the nasals, and the incisors are longer and heavier.

Specimen.—One, the type.

Measurements.—Collector's measurements are as follows: head and body, 200; tail, 155; foot, 50. The total length of the skull is about 54; interorbital width, 14.3; shortest length of nasals, 16 8; tips of nasals to caudal terminations of the premaxillaries, 20 7 mm

Remarks—No specimen of the Yunnan race *ornatus* is available, but this is easily distinguished from *lentus* by the ferruginous cheeks extending nearly to the level of the ears. In the same respect the latter differs from the typical race, and from *belfieldi* which has not only bright cheeks but much ferruginous in the tail as well.

Sciurus caniceps canigenus subsp nov.

Type—Male adult, skin and skull no 241509, U S. National Museum, from Hayenhsien, Hangchow Bay, Chekiang, China, December 10, 1925. Collected by Arthur de C. Sowerby, original number 1515

Diagnosis.—A rather small race Chin and cheeks very gray and without facial markings. No silvery tips to the hairs of the tail, and the terminal tuft exhibits a tendency to be black at base

Skin.—The dorsal surface is of the normal sciurine annulated pattern, perfectly uniform save for a barely appreciable tendency toward darkening upon the head, though not upon the shoulders The dorsal hairs have pale tips and the general tone of this surface varies from brownish to paler and grayer, this possibly being due to age but not to season. The cheeks, muzzle and chin are dark silvery gray with no vestige of brown. The ears are short and scantily haired and there is a whitish postauricuar spot entirely hidden by the ears in the dried skins. The tail is unicolor with the back save that the annulations are coarser. There are no white tips to the caudal hairs but the terminal tuft exhibits a tendency—very strongly marked in one individual—to be black at base with the usual buffy tips to the hairs. The feet are gray, modified by the presence of black hairs The gray of the chin extends upon the throat, but in the grayer specimens especially this is altered upon the chest to a creamy tint, and in the browner ones, to a faintly ochraceous overwash, which extends over the belly and the inside of the hind legs.

Skull—As with so many sciuromorphs, there is nothing particularly distinctive cranially, save that the skull is much smaller than in true *caniceps*.

Measurements—Collector's measurements of the type are: head and body, 194; tail, 156, hind foot, 47, and ear, 21 mm. Measurements of the skull are: total length, 50; zygomatic width, 30.5; interorbital width, 17, and upper tooth row, 10 mm.

Material.—Two specimens from Kangpu and three from Haiyenhsien, both localities in Chekiang.

Remarks.—The relationship of this race unquestionably lies with *caniceps*, although it may ultimately be advisable to assign it full specific rank. The occurrence of a squirrel of this group so far east in China is somewhat of a surprise. As the specimens at hand were taken in winter it is evident that this form does not assume a brighter coat at this season as do some of the other subspecies. Unfortunately, the only skin available of true *caniceps* is in this bright pelage, but it is evident that *canigenus* is browner about the top of the head, the feet are more silvery (less buffy), and *caniceps* entirely lacks the ochraceous wash of the underparts.

Petaurista rubicundus, sp. nov.

Type.—Nursing female, skin only; no. 240857, U. S. National Museum, from Mapientung, Szechwan, China. Killed by native hunters in the fall of 1924 and secured by D. C. Graham.

Diagnosis.—A flying squirrel with underparts light but bright rufous; face, chin, sides of neck and feet darker rufous, and hairs of the remainder of the body giving the appearance of being broadly tipped with the same color. Tip of tail black.

Skin.—The underparts are palest mediad, being almost apricot color, but gradually deepening to intense rufous upon the throat and borders of the membranes. The feet are of the same color but a trifle darker. The pelage of the dorsal surface is thick and full, plumbeous at base, the shorter hairs with brown tips. The very numerous guard hairs are annulated first very dark brown, then black for one or two millimeters followed by ochraceous rufous for some ten millimeters, and finally, short tips of glossy black, the latter hardly distinguishable in general effect. The ears are thin and almost hairless, and the postauricular spots are not differentiated. The hairs of the face are deep rufous with plumbeous bases and short black tips, resulting in a rich effect. The proximal portion of the tail is dull mahogany, with short black tips that gradually lengthen caudad until the tail tip is entirely black. The skin is unaccompanied by measurements but the hind foot has a length of about 72 mm.

Material.—One specimen, the type.

Remarks.—The type is a flat skin in beautiful pelage and the animal was skinned through the mouth in a truly expert manner, leaving no discernible break in the pelt. Unfortunately the skull is missing, but the specimen is evidently so different from anything heretofore described that I have no choice but to name it. An effort to establish tentative relationship with some of the Indian members of the genus was without result.

Petaurista sulcatus, sp. nov.

Type.—Female adult, skin and skull no. 219206, U. S. National Museum, from Hsinlungshan, 65 miles northeast of Peking, Chihli, China, altitude 3000 feet; August 18, 1917. Collected by Arthur deC. Sowerby, original number 1017.

Diagnosis.—A small *Petaurista* with dorsal coloration of the general type of *P. melanopterus*, *leucogenys*, etc. Maxillary incisors, very broad, each with a well-defined groove.

Skin.—The hairs of the middle back are plumbeous at base and browner distad, while numerous longer hairs have buffy tips. The hairs of the sides, especially upon the hips, and of the upper parachutes, lack the browner distal portion mentioned above and appear almost black, except for the buffy tips. There is but the suggestion of an ochraceous spot behind the ear, and ochraceous areas upon both eye lids. The remainder of the head is distinctly lighter than the back and much grayer. The dorsum of the feet is so dark as to be practically black, ticked with a few buffy hairs. Upon the under surface of the body proper of the type specimen the hairs are palely plumbeous at base with white tips upon those over the throat and hinder belly, but with buffy tips elsewhere, while the hairs of the ventral surface of the parachute are wholly ochraceous. In the skin of the topotype these latter have plumbeous bases. There is a sharply-defined sooty spot upon the chin as is usual in many species.

Skull.—In general conformation the skull much resembles that of *leucogenys*, but the total breadth, as well as the width of the rostral tip, is narrower, and the interpterygoid fossa is much deeper. The molariform teeth are of the same type as in *melanopterus*, the premolar being a trifle smaller than the first molar. The maxillary incisors are broad (3 mm.) with a well defined, broad groove laterad to the middle. Close inspection shows that this groove exhibits a tendency toward doubleness, with an extremely faint ridge between. The mandibular incisors are correspondingly robust.

Measurements.—Collector's measurements of the type and topotype are: head and body 310-305, tail, 343-330, foot 65-63, and ear, 40 mm. Measurements of the skulls are: condylobasilar length, 54-52.5, zygomatic width, 41.5-41, interorbital width, 15-14.6, maxillary tooth row, 13.7-14, and greatest width of maxillary incisive alveoli, 8.7-9.

Material.—Three specimens: two, including the type, from Hsinlungshan, and one skin without skull from Eastern Tombs, Chihli.

Remarks.—All specimens of the Chinese members of this genus of what may be termed the normal sciuropterine type of coloration have heretofore been referred to either *P. melanopterus*, *xanthotis*, or *filchnerinae*. The last is a large squirrel probably identical with *xanthotis*. Since Milne-Edward's original description of the last-mentioned, the only published record of its capture noted is that by Lyon (1907) of a specimen from Kansu. This is before me and seems to be at least subspecifically distinct from *melanopterus*, and differences in the molar pattern renders it not unlikely that the relationship is not that close. At any rate, these flying squirrels are of large size with skulls normal, including narrow, simple, maxillary incisors.

The reference of chief interest in the present connection is that of Pere Huede (Mems. Hist. Nat. Emp. Chinois, IV, 1898). In this there is quite lengthy discussion of the molar pattern of several flying squirrels, but none of the incisors. His identifications need careful checking, to say the least, but his plates seem to be exceptionally good and accurate. Turning to his figures illustrating several views of his so-called *Pteromys melanopterus* it is at once seen that this is a very different animal from that of Milne-Edwards, distinguishable instantly by the broad, *grooved*, maxillary incisors. Comparison shows that these figures are exceptionally fine representations, in every respect, of the skull of *P. sulcatus*.

It was at first thought that this character was probably of generic significance, but it was found that the maxillary incisors of *P. fulvinus*—a very different type of squirrel—may vary from the pattern normal for the genus in somewhat the same direction. In four skulls from Kashmir two have simple incisors, a third is faintly ridged and grooved, and a fourth more definitely has four faint ridges and three equally faint grooves of the same width between them. To my mind this circumstance at once settles in the negative the question of generic, or even subgeneric, separation of the Chinese examples.

The skin from Eastern Tombs, without skull, date, or measurements, is almost certainly a winter specimen of this species. Its pelage is denser, it largely lacks the ochraceous tone to the underparts of the body proper, and the head is considerably darker; but it is similar in other respects.

ENTOMOLOGY.—*Notes on the Dexiid genera* Cordyligaster *and* Eucordyligaster.[1]

J. M. ALDRICH, U. S. National Museum. (Communicated by S. A. ROHWER.)

In some material received from Professor Melander was a specimen of a yellow *Cordyligaster* from South America; the process of identification led to some results worthy of publication. It would seem that no yellow forms have come to light since the description of two species about eighty years ago.

There are two American genera closely allied in all but one character. In *Cordyligaster* the calypters are very small, while in *Eucordyligaster* they are of normal size. The difference is striking. The former genus has three known species and the latter two; all five are tropical, but one has a wide northern range and is common in the vicinity of the District of Columbia. This species, *Eucordyligaster minusculus*, is so unmistakeable and so well represented in collections that the generic characters may be omitted here.

CORDYLIGASTER Macquart

Cordyligaster Macquart, Dipt. Exot. **2** (pt. 3): 247 (reprint 90) 1843.—Schiner, Novara, 322. 1868.—Van der Wulp, Tijdsch. v. Ent. **28**: 191. 1885; Biologia, Dipt. **2**: 252 1891.—Coquillett, Type-Species N. A. Dipt 527. 1910.—Adams, in Williston's Manual, 356. 1908.—Townsend, Ins. Ins. Menst **4**: 122. 1916.

Megistogaster Macquart, Dipt. Exot. Suppl **2** (pt. 2): 185 (reprint 212) 1851.—Townsend, Ins. Ins Menst. **4**: 7. 1916.

Cordylidexia Giglio-Tos, Ditt. del Mess **3**: 67. 1894.

Eucordylidexia Townsend, Ins. Ins. Menst. **3**: 41. 1915.

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[1] Received January 18, 1927.

The sole original species of *Cordyligaster* was *Dexia petiolata* Wiedemann; *Megistogaster* had two species, of which Townsend designated *fuscipennis* Macquart as type in 1916; *Cordylidexia* was a new name proposed on account of supposed preoccupation, taking *Dexia petiolata* as type. Coquillett, 1910, showed that the name is not preoccupied in the strict sense. *Eucordylidexia* was proposed for a new species, *E. alegulata* Townsend, which Townsend subsequently stated was a synonym of *petiolata*.

Key to Species of Cordyligaster

1. Antennae, palpi, legs and abdomen black. . . . **petiolatus** Wiedemann
   Antennae, palpi, legs and abdomen yellow or mostly so. 2
2. Femora with black bands, hind coxae black . **tipuliformis** Walker.
   Femora and hind coxae yellow . . . . **analis** Wiedemann.

Cordyligaster petiolatus Wiedemann.

Dexia petiolata Wiedemann, Auss. Zweifl 374. 1830

Cordyligaster petiolatus Macquart, Dipt. Exot **2** (pt 3): 247 (reprint 90) 1843.—Rondani, Esame. . . . Ditt. Brasil. 76. 1848 —Schiner, Novara 322 1868 —Van der Wulp, Tijdsch. v Ent **28**: 191 *pl 6, f. 1, 2.* 1885.—Townsend, Ins Ins Menst **4**: 122. 1916.

Megistogaster fuscipennis Macquart, Dipt. Exot. Suppl. **2** (pt. 2): 186 (reprint 213), *pl. 19, f. 7.* 1851.

Eucordylidexia alegulata Townsend, Ins Ins. Menst. **3**: 41 1915

Originally described from Brazil, and reported from Panama, Costa Rica and Guatemala by Townsend, in 1915. In addition to the specimens mentioned by Townsend, the National Museum now has two from Rurrennabaque, Rio Beni, Bolivia,collected by Dr. Wm. M. Mann on the Mulford Biological Exploration, and one from Belem, Pará, Brazil, collected by F. X. Williams for the Hawaiian Sugar Planters' Experiment Station.

Cordyligaster analis Macquart

Megistopoda analis Macquart, Dipt. Exot. Suppl. **2** (pt. 2) 187 (reprint 214). 1851.

Cordyligaster analis Townsend, Ins. Ins. Menst. **4**: 122. 1916.

Described from a single male from the Amazon. The type had the fourth abdominal segment black except its anterior border. The specimen from Professor Melander, a female which I provisionally place here, is from British Guiana (Parish, collector); it has the fourth abdominal segment wholly yellow, as well as the legs and coxae. The only black color is on the thoracic dorsum, base of scutellum, metanotum, and a spot just above the hind coxa, which fades out upward. There is only a single pair of orbital bristles, the upper. The dorsum and pleurae are covered with golden pollen, but on the former the black remains visible in four large oval spots arranged in a square.

Cordyligaster tipuliformis Walker

Cordyligaster tipuliformis Walker, Trans. Ent. Soc. new ser. **4**: 205 (reprint 17). 1857.—Townsend, Ins. Ins. Menst. **4**: 122. 1916

Described from a female, from "South America." I know of no other specimens. Townsend thought this and *C. analis* must have been described from immature or bleached specimens, but my new yellow specimen is perfectly normal, rendering this explanation improbable. Walker describes the abdomen as ferruginous, the base of the second and third segments testaceous.

EUCORDYLIGASTER Townsend

Eucordyligaster Townsend, Ins. Ins. Menst. **4**: 123. 1916.

The type was designated as *Cordyligaster septentrionalis* Townsend. Within recent years the National Museum has received a cotype of *Cordyligaster minusculus* Van der Wulp, which has been compared with the type of *septentrionalis* and proves to be the same species.

EUCORDYLIGASTER MINUSCULUS Van der Wulp

Cordyligaster minusculus Van der Wulp, Biologia, Dipt. **2**: 252, *pl. 6, f. 7, 7a.* 1891.—Banks, Ent. News **18**: 450. 1907.—Thompson, Psyche **17**: 212. 1910.—Johnson, Psyche **19**: 103. 1912.—Daecke, Ent. News **26**: 42. 1915.
Eucordylidexia minusculus Giglio-Tos, Ditt. del Mess. (pt. 3) 67. 1894.
Cordyligaster septentrionalis Townsend, Ann. Ent. Soc. Amer., **2**: 212. 1909, Ins. Ins. Menst. **3**: 41. 1915.

The species, as already stated, occurs commonly about Washington. Daecke notes it at Marietta, Pa., the farthest north of the records. Thompson pointed out the synonomy of *septentrionalis*.

EUCORDYLIGASTER NYOMALA Townsend

Cordyligaster nyomala Townsend, Ins. Ins. Menst. **2**: 93. 1914.
Eucordyligaster nyomala Townsend, Ins. Ins. Menst. **4**: 123. 1916.

Known only in the single male type from Ñomala, Peru. It is readily distinguished from *septentrionalis* by its yellow palpi; the thoracic dorsum is covered with golden pollen with faint dark stripes in front; the antennae are dark red.

ENTOMOLOGY.—*Descriptions of new genera and species of Mallophaga, together with keys to some related genera of Menoponidae and Philopteridae.*[1] H. E. EWING, U. S. Bureau of Entomology. (Communicated by S. A. ROHWER.)

In the Chapin collection of ectoparasites, recently donated to the United States National Museum, are some rare, and in many instances unusual, Mallophagan specimens. These specimens, mounted by Dr. E. A. Chapin, are in excellent condition for showing many of those minute chitinous structures which are coming to have such an important part in our recent diagnoses of Mallophagan genera and species. In this paper six new genera are established. Although no figures are given, it is believed that the keys supplied will show probably more

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[1] Received January 19, 1927.

clearly than figures would, the significant taxonomic characters and also the relationships of the newly established genera to the previously described ones. The generic concept used in establishing these genera predicates that all the species of the genus shall possess two or more correlated characters of more than specific importance. In addition to the six new genera proposed, seven new species are described.

A NEW SPECIES OF TRIMENOPONIDAE

Philandesia foxi, new species

Forehead provided with only small setae. Antennae four-segmented; second segment with very broad, truncate process, bearing two long setae at angle, last segment longer than broad. A short seta is situated on expansion over antennal fossa just in front of the eye

Prothorax about two-thirds as broad as head and with a marginal row of about a dozen long setae, as well as a pair of small spine-like setae on the angles and another pair behind the first pair of long marginal setae. Pterothorax slightly broader than the prothorax and with straight, strongly divergent sides

Each abdominal segment typically with a distinct, posterior, transverse row of setae and an indistinct anterior transverse row. Next to last segment of male about twice as long as the others. Last segment of female with a double comb of short, marginal setae

Genital armature of male very peculiar The structure taken to be the basal plate arises from about the middle of the abdomen and is divided into four processes; two short outer processes that are broadened and provided with a spine-like appendage distally; and two long inner processes Parameres free, straight and broadened at their tips; endomeres united, extending beyond the tips of parameres

Length of female, 2 12 mm.; width, 0 93 mm Length of male, 2.20 mm width, 0 81 mm

Type host and *type locality.*—*Marmota flaviventris* from Brewster, Washington State.

Type —Cat. no. 40135, U. S N M

Described from one male (holotype) taken from type host collected 1918, by F. W. Logan, Brewster, Washington, and from one female collected at New York City, from a rat (*Rattus norvegicus*) and sent in by Dr. Carroll Fox. The manuscript name, without description, of this species was published in a list of ectoparasites of the genera *Rattus* and *Mus* for the New World by Fox in his "Insects and Disease of Man," page 217. This name, so published in 1925, is a *nomen nudum*, and becomes validated with this description. *P. foxi* differs from *P. townsendi* Kellogg and Nakayama in a number of characters. It has eight large setae on the posterior margin of the head instead of the four as on *townsendi*, and at least a dozen large marginal setae on the prothorax instead of the half dozen of the other species. This species is also related to species of *Dennyus* in a number of ways.

NEW MENOPONIDAE

Acolpocephalum, new genus

Last antennal segment subhemispherical. Eyes degenerate, situated on margin just behind antennal notch. Pterothorax enlarged, broader and much longer than prothorax. Abdomen with nine segments, first and second similar. Legs very short and stout, femora inflated; first tarsal segment extending distally and overlapping second for over half the length of the latter. Tarsal claws very small and weak, almost vestigial on second and third legs.

Genotype and its *host species.—Acolpocephalum brevipes*, new species, from *Ptiloris victoriae*

Only a single species is included at present in this new genus The tarsal characters found in this species are different from those of any Mallophagan species known to the writer.

Acolpocephalum brevipes, new species

Head compact, as broad as long. Free margin of forehead almost but not quite, evenly rounded Mandibles sharply pointed, without crushing surfaces or transverse ridges, left mandible slightly smaller than right and with two sharp, tooth-like projections at the end. Temporal lobes subquadrangular

Prothorax about three-fifths as broad as the head, with rounded lateral margins and a peg-like spine on anterior corner Pterothorax as broad as greatest width of abdomen, sides slightly outwardly curved and strongly divergent posteriorly A few spine-like setae are situated at each posterior corner of pterothorax.

Abdomen about one and a half times as long as broad and with posterior end broadly and evenly rounded A long seta springs from the lateral margin of each segment, which typically bears in addition a transverse row of setae.

Legs almost of the same size, but second pair slightly larger than the first and the third slightly larger than the second. Femora of all the legs about two-thirds as broad as long, those of third pair not quite as stout as those of the other two pairs Tibiae of all legs very short and stout, those of first pair about one and a half times as long as broad at their distal ends. Last segment of each tarsus very stout, strongly curved on outer margin and terminated with minute to vestigial claws; claws on tarsus I best developed, the outer about twice as large as the inner.

Length of female, 1.11 mm., width, 0.41 mm.

Type host and *type locality.—Ptiloris victoriae*, from Queensland, Australia.

Type.—Cat no. 40136, U. S. N. M.

Described from a single female (holotype) taken from skin of rifle bird, *Ptiloris victoriae*, from Atherton Tableland, Queensland, Australia.

Chapinia, new genus

Forehead greatly reduced, broadly rounded in front. Mandibles situated almost approximate to anterior, free margin of clypeus. Last segment of antenna capitate. Antennal fossa covered above by a transversely notched expansion of the head, the posterior part of which bears the double cornea of the eye on its free margin. Prothorax large, with almost straight, posteriorly convergent sides. Pterothorax undivided, with almost straight, posteriorly divergent sides. Abdomen broad, of nine segments in female and ten in male; first and second segments similar. First segment of each tarsus but slightly overlapping the second; tarsal claws well developed and subequal on each tarsus. Genital plate of male broad and flat, not rod-like.

Genotype and its *host species*—*Chapinia robusta*, new species, from *Ceratogymna atrata.*

This genus is established for the single new species, and at the suggestion of Dr. Chapin, the collector of the specimens. It is related to *Actornithophilus* Ferris but differs from Ferris' genus in the shape of the forehead, position of the mandibles and type of genital armature of the male.

Chapinia robusta, new species

Head decidedly "hat-like," the almost straight contour of the sides of the forehead is continued far beyond the bases of the antennae and along the side of expansions over the antennal fossae Mandibles small, equal, simple and pointed at tips. Antennae of typical *Menopon* type, but third segment revealing traces of its fused condition by breaking off easily near its base at suture line; last segment slightly longer than broad

Prothorax about two-thirds as broad as head and bearing a conspicuous spine at each anterior corner. Pterothorax the mirror of prothorax considerably enlarged. At each posterior corner of pterothorax there is a lateral pecten of five or six spine-like setae, two of which in the female are much longer than those of the male.

Abdomen broad, constricted somewhat in front and bearing a few very long lateral setae, those on the seventh and eighth segments being especially conspicuous.

Genital armature of male large and heavily chitinized. Basal plate extending backward from fifth abdominal segment, it is broad and strap-like Posteriorly the basal plate divides into two slender lateral arms and a stout, distally split central piece; which structures bear the parameres and endomere respectively. Parameres rather slender, upwardly curved, more or less hook-like structures which encompass the endomere laterally Endomere large and curved, plate-like with a pair of lateral horns. Penis absent.

Legs long, the tibial segments particularly being slender. Patch of setae on each posterior femur pronounced. Second tarsal segments of all the legs very slender.

Length of male, 1.59 mm.; width, 0.70 mm. Length of female, 2.00 mm.; width, 0.95 mm.

Type host and *type locality.*—*Ceratogymna atrata* from Congo, Africa.

Type—Cat. no. 40137, U. S. N. M.

Described from one male (holotype) and one female (paratype) collected by E. A. Chapin from the skin of hornbill, *Ceratogymna atrata*, taken November 3, 1917, at Nytonga, Congo, Africa.

Amyrsidea, new genus

Forehead reduced and evenly rounded in front. Antennae five-segmented (third segment showing suture near base), with last segment cylindrical. Antennal fossa covered above by a transversely sutured expansion of the head. Eyes wanting. Pharyngeal sclerite well developed. Prothorax large, without sternum, the sternal region being largely covered by the plate-like coxae of first pair of legs. Pterothorax broader than long and with straight posterior margin Female with a whorl of conspicuous subequal spines on the posterior margin of last abdominal segment. Typically each abdominal segment is provided on each side ventrally with a brush of setae, smaller than those which clothe the body. Femora of third pair of legs each with a ventral patch of setae. First tibiae without spurs at distal ends; second and third tibiae provided with tibial spurs. First tarsal segment of leg I large and overlapping the second segment, first tarsal segment of legs II and III much smaller and not overlapping second segment. Subequal tarsal claws well developed on all the legs. Genital armature of male compact but complicated. Basal plate, plate-like, but very deeply incised posteriorly for the reception of the complicated endomeres and bearing thorn-like projections from the inside margins of lobes bounding incised space. Parameres free, movable appendages

Genotype and its *host species.*—*Menopon ventrale* Nitzsch, from *Argusianus argus*

This genus is established for the peculiar *Menopon* of *Argusianus* species The writer has examined three males and three females of this species taken from the argus pheasant, *Argusianus argus*, collected at Trong, Lower Siam, and one female from *Argusianus grayi* taken in West Borneo. The absence of eyes, the presence of tibial spurs on the second and third tibiae, the whorl of spines on the last segment of the female and the peculiar and complicated genital armature of the male constitute a striking combination of characters for the delimitation of the genus.

Numidicola, new genus

Forehead reduced and broadly rounded. Antennae long, five-segmented, third segment small and forming a pedicel to the fourth, fifth segment long, filiform Antennal fossae roofed over above by an unsutured expansion of the head Eyes vestigial and on the free margin of expansions over antennal fossae. Pharyngeal sclerite large, conspicuous. Prothorax very large, about as broad as head, prosternum wanting; large, plate-like precoxae meeting on median line Pterothorax not larger than prothorax, very short, sides markedly divergent posteriorly. Abdomen with very short segments, eight in the male and nine in the female, each typically with a single transverse row of setae. First tarsal segment of each tarsus but slightly if at all overlapping the second. Each tarsus terminated distally with two well-developed, equal claws Genital armature of male with rod-like basal plate, free parameres and large distally free endomeres.

Genotype and its *host species.*—*Numidicola longicornis*, new species, from *Numida ansorgii.*

Included with the type species in this genus is the *Menopon antennatum* of Kellogg and Paine. The combination of two characters is enough to distinguish this genus from the others of *Menoponidae*. These are the presence of long, filiform, five-segmented antennae and the position of the eyes on the margins of the undivided expansions of the head covering the antennal fossae.

Numidicola longicornis, new species

A fragile, very hairy, golden colored species. First segment of antenna slightly longer than broad; second segment cylindrical, twice as long as first, third segment minute, enlarged toward the tip, about half as long as the fourth; fourth about half as long as the fifth and broadest toward its distal end; fifth segment filiform, not clubbed, although it is broadest near the tip; it is about one and a half times as long as three and four combined. Eyes vestigial, without pigment, but showing two degenerate corneas.

Prothorax as broad as the head, broadly rounded posteriorly and bearing a marginal row of closely set, long setae Pterothorax with a few spine-like setae on lateral margins and a row of close-set, long setae on posterior margin Abdominal setae in close-set rows, some of them somewhat flattened. Last abdominal segment of male studded above with many short spines.

Genital armature of male: Basal plate long, flat, widening posteriorly, parameres long, slender slightly curved and blunt-pointed at tips; endomeres similar to parameres but stouter, attached to sac, outwardly curved. The endomeres extend posteriorly slightly beyond the parameres.

Hind legs slightly larger than the middle ones, femur III with ventral patch of setae. Tibiae II and III each with about eight spines on inner side, the more distal being the stoutest.

Length of male, 1.35 mm , width, 0.64 mm. Length of female, 1.26 mm ; width, 0.71 mm

Type host and *type locality.*—*Numida ansorgii* from British East Africa

Type slide.—Cat no 40138, U. S N. M

Description based on five males and one female (two immature specimens were obtained) taken from the skin no 243182 U S. N. M , of the guinea, *Numida ansorgii*, collected at Tana River, British East Africa, August 26, 1912. This species differs from *N. antennatum* (Kellogg and Paine) in the shape of the antennal segments and in the structure of the genital armature of the male.

KEY TO SOME RELATED GENERA OF MENOPONIDAE, INCLUDING THOSE DESCRIBED IN THIS PAPER

1. Antennal fossae open above (ocular emarginations deep) or only slightly covered by expansions from head; last segment of antenna usually clavate, rarely capitate; temporal lobes large, somewhat subrectangular; eyes present, and not vestigial 2
   Antennal fossae largely or entirely covered above by lateral expansions from the top of head; last segment of antenna variously shaped, temporal lobes rarely subrectangular, eyes usually present, but frequently degenerate 6
2. Posterior femora and abdominal sterna without definite ventral patches of setae, although combs of spines may be present . . . 3
   Posterior femora and certain abdominal sterna with definite ventral patches or brushes of setae 4

3. Pterothorax (meso-metathorax) enlarged, much larger than prothorax; first segment of each tarsus overlapping the second for about half the length of the latter; tarsal claws minute to vestigial. Small stout lice on parrots. . . . . **Acolpocephalum**, new genus
   Pterothorax normal; first segment of each tarsus slightly or not at all overlapping the second; tarsal claws not vestigial **Colpocephalum** Nitzsch
4. Setae of femoral and sternal patches smaller than those clothing the body **Heleonomus** Ferris
   Setae of femoral and sternal patches as large as those which clothe the body 5
5. Forehead broad and rounded with large mandibles in normal position; genital armature of male weak with long rod-like basal plate **Actornithophilus** Ferris
   Forehead reduced, triangular, with small mandibles situated approximate to the front margin of clypeus; genital armature of male large with broad basal plate . **Chapinia**, new genus
6. Posterior femora and certain abdominal sterna with definite ventral patches or brushes of setae . 7
   Posterior femora and abdominal sterna without definite ventral patches or brushes of setae 8
7. Pharyngeal sclerite present; second abdominal sternite sometimes with a pair of asters of heavy spines on posterior margin 8
   Pharyngeal sclerite wanting, second abdominal sternite never with asters of spines . **Dennyus** Neumann
8. Temporal region of head of usual shape, and much broader than forehead and prothorax; posterior margin of last abdominal segment without row of spine-like setae; prosternum present, last antennal segment capitate **Myrsidea** Waterston
   Temporal region reduced, but little broader than forehead or prothorax; prosternum wanting; procoxae expanded into body sclerites; last antennal segment not capitate 9
9. Expansion of head skeleton covering top of antennal fossa divided by a transverse suture; female with a row of stout spines on the posterior margin of last abdominal segment . . **Amyrsidea**, new genus
   Expansion covering top of antennal fossa entire; female without spines on posterior margin of last abdominal segment **Numidicola**, new genus

NEW PHILOPTERIDAE

Echinophilopterus, new genus

Clypeus separated from head by distinct clypeal suture; appearing deeply incised in front because of the lateral chitinizations (clypeal bands) extending beyond the signature for about a third of their length. Trabeculae very large, long and rounded at their tips. Antennae short. Abdomen short, almost circular and bearing many short, stout spines below on first, second and possibly third or fourth segments. Other characters similar to those of *Philopterus* Nitzsch.

Genotype and its *host species.*—*Echinophilopterus chapini*, new species, from *Tanygnathus muelleri.*

This new genus is established for those parrot-infesting *Philopteri* that have the abdomen studded below with short, stout spines. It was suggested to the author by Dr. E. A. Chapin, who collected the type species. Besides the type species and another new one described in this paper, there are included in this genus some of the species in Piaget's *forficulatus* group. The writer was at first inclined to make *forficula* Piaget the type of this genus but changed his mind when it was observed that Piaget does not mention the group of spines on the ventral surface of the abdomen nor give any definite type host species for this louse.

Echinophilopterus chapini, new species

Head large for the size of body, with long forehead. Signature of clypeus much longer than broad, sides very slightly outcurved, and with a short, tongue-like anterior median process having a rounded hyaline margin. Lateral chitinizations of clypeus pronounced, extending beyond the signature by about a third of their length, pointed and hyaline at their tips; each bears two prominent, curved setae above. Trabeculae reaching to the middle of second antennal segment, slightly recurved and evenly rounded at tips.

Prothorax about two-thirds as large as pterothorax, sides straight and slightly divergent posteriorly. Pterothorax with a long seta on each lateral margin, in front of which is a small spine-like seta and behind which are two setae, the most posterior of which is the longer.

Abdomen almost as broad as long and in both sexes bearing below many short, stout, sharp spines which are situated chiefly on the first three segments. In three specimens one or more spines are also on the fourth segment

Genital armature of male stout, compact and well chitinized. Basal plate about twice as long as wide, sides almost straight and subparallel. Parameres short, stout, outwardly curved hooks, in length equal to about half the width of basal plate. Endomeres wanting A penis-like structure extends almost to the tips of parameres

Length of male, 1.66 mm.; width, 0.71 mm Length of female, 2 06 mm.; width 0 87 mm.

Type.—Cat. no. 40139, U. S. N M.

Described from four specimens, two males and two females, taken from skins of a parrot, *Tanygnathus muelleri*, collected in the Celebes.

Echinophilopterus tanygnathi, new species

Head large, particularly the temporal region. Signature of clypeus much longer than broad, sides almost straight and parallel; a short, tongue-like projection extends from the middle of the anterior end of the signature. Lateral chitinizations of clypeus very long, with anterior free ends expanded, inwardly cupped and hyaline; above slightly in front of the middle each bears two long curved setae and near the base a single, straight seta. Trabeculae reaching almost to the middle of the second antennal segment, decidedly broadened at their bases.

Prothorax almost as large as pterothorax, sides straight and very slightly divergent posteriorly. No lateral marginal setae on prothorax, but there is a minute spine and a much larger seta at each angle. Chaetotaxy of lateral margin of pterothorax: First a small spine, next a long more or less flagelliform seta equal to about half the width of the pterothorax, next a similar seta half as long, last a very long seta equal to three-fourths the width of the pterothorax.

Abdomen distinctly longer than broad. Ventral spines distributed over the central halves of the first three segments. Last segment of abdomen broader than long.

Length of female, 1 79 mm.; width, 0 73 mm.

Type host and *type locality*—*Tanygnathus burbridgei* from Sulu Island, Philippine Islands

Type—Cat. no 40140, U. S N M.

Described from a single female (holotype) taken from a skin of a parrot, *Tanygnathus burbridgei*, collected at Mt. Bud Dajo, Sulu Island, Philippine Islands, October 11, 1906

Differs from *E chapini* in having a longer central process on anterior end of signature of clypeus, in having shorter and stouter and differently shaped trabeculae and in some minor characters

Physconelloides, new genus

Clypeus broadly and evenly rounded in front, clypeal suture present. Forehead with a pair of large, backwardly pointing, lateral horn-like or spine-like processes which arise from the chitinous thickening just behind the clypeal sutures. A similar but smaller pair of processes arise ventrally from the clypeus just in front of the clypeal sutures Antennae short, second segment longest Temporal lobes large, squarish. Eyes concealed from above the lateral expansions of the temporal lobes Esophageal sclerite present and well developed. Prothorax smaller than the pterothorax, with sides strongly divergent posteriorly Pterothorax short, but very broad with rounded lateral margins Abdomen eight-segmented in both sexes Genital armature of male very long and slender, basal plate composed of two long chitinous rods, parameres free, conspicuous; endomeres not united distally Tarsal claws unequal, the inner being the stouter and having a different curve from the outer

Genotype and its *host species*—*Physconelloides ceratoceps*, new species, from *Leptotila ochroptera chloranchenia*.

This new genus is clearly related to *Physconella* Paine but differs from Paine's genus in having the large horn-like process on the underside of the clypeus in addition to those on the sides of the forehead, and in having the angulate temporal lobes instead of rounded ones The type species is the only one included in the genus.

Physconelloides ceratoceps, new species

Clypeus heavily chitinized along the front margin; ventral processes recurved, equal to the second segment of antennae in length. Lateral processes of head about one and a half times as long as ventral processes and overlapping most of the first antennal segment. Antennae short, first segment as broad as long; second segment about twice as long as broad and equal to three and four together; fifth segment distinctly longer than fourth.

Temporal lobes squarish, each with a minute spine-like seta on outer corner and two very long setae on posterior margin. Pharyngeal sclerite as broad as long.

Prothorax with a pair of setae just in front of posterior angles. Pterothorax about three times as broad as long, with lateral margins almost evenly rounded and each bearing a large seta near its middle.

Abdomen somewhat pear-shaped in outline with the broadest place behind the middle. Tergal and sternal plates apparently wanting. Pleural plates heavily chitinized and more or less united with each other. Abdomen almost nude except for three long lateral setae on each side of sixth segment and two on each side of seventh segment in the female and two large setae on each side of seventh segment and a posterior marginal pair on the eighth segment of male.

Genital armature of male very slender and delicate; basal plate arising from the chinitized base of first abdominal segment and extending through almost the whole length of the abdomen as two slender rods, parameres outwardly directed, almost straight processes thickened at their bases, endomeres free and similar to parameres.

Coxae of first pair of legs contiguous. Those of second pair of legs separated from each other for a distance about equal to the diameter of one of them by the expanded, plate-like epimera behind the first coxae. The inner tarsal claw of front leg is about twice as big as the outer and differently curved, it is also slightly larger than the outer one on the second and third pairs of legs.

Length of female, 1.65 mm., width, 0.66 mm. Length of male, 1.11 mm.; width, 0.52 mm.

Type host and *type locality*.—*Leptotila ochroptera chloraucheuia*, from Argentina.

Type slide.—Cat. no. 40141, U. S. N. M.

Described from a male (holotype) and a female (paratype) taken from type host, a pigeon, which was collected at Rio Quia, Las Palmes, Argentina Chaco, July 17, 1920, by Dr. A. Wetmore.

KEY TO SOME RELATED GENERA OF PHILOPTERIDAE, INCLUDING THE TWO NEW GENERA DESCRIBED IN THIS PAPER

1. Forehead produced laterally into a pair of large, recurved horn-like processes . . 2
   Forehead not produced laterally into horn-like processes 3
2. Temporal lobes rounded, clypeus without ventral spine-like processes **Physconella** Paine
   Temporal lobes angulate, clypeus provided with a pair of large, spine-like processes on ventral side . . **Physconelloides**, new genus
3. Forehead with membranous flaps (more conspicuous in the male) projecting beyond the lateral margins. (The Giebeliinae of Waterston) 4
   Forehead without laterally projecting membranous flaps . . 5
4. Antennae the same in the two sexes On petrels **Giebelia** Kellogg
   Antennae different in the two sexes. On giant fulmars and shearwaters **Trabeculus** Rudow
5. Antennae alike in the two sexes; trabeculae very large and usually movable . . 6
   Antennae different in the two sexes. On owls **Strigiphilus** Mjoberg

6. Forehead irregularly rounded and without hyaline margin to clypeus; trabeculae reduced, immovable, not reaching the distal end of first antennal segment. On owls . . . . . **Eustrigiphilus** Ewing
 Without such characters 7
7. Clypeal region expanded and with hyaline free margin throughout, but rounded and not emarginate in front, antennae very short. On geese, ducks and swans . . . **Anatoecus** Cummings
 Clypeal region not rounded in front with free hyaline margin . . 8
8 Signatural plate divided; antennae long, with segment two distinctly longer than any of the others. On ibises . . **Ibidoecus** Cummings
 Signatural plate not divided 9
9. Clypeal margin deeply incised in front; abdomen bearing many short, sharp spines below. On parrots **Echinophilopterus**, new genus
 Clypeal margin not deeply incised in front; abdomen without spine on ventral surface . . . 10
10. Clypeal region bearing above on each lateral chitinization (clypeal band) a tuft of three or more setae. Chiefly on cuckoos **Cuculoecus** Ewing
 Clypeal region not bearing such lateral tufts of setae
 Part of genus **Philopterus** Nitzsch and its derivatives, **Neophilopterus** Cummings and **Dollabella** Cummings.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

194th MEETING

The 194th meeting of the Academy and the twenty-seventh annual meeting was held at the Administration Building of the Carnegie Institution on the evening of Tuesday, January 13, 1925. The meeting was called to order by Vice-President Hazard, who called upon the retiring President, A. L. Day, to give his address entitled, *The study of earth movements in California.* President Day gave a brief account of the events leading to the movement for the cooperative study of earthquakes and earth movements and the formation of the Advisory Committee of Seismology in order to make the cooperation effective. He mentioned the various lines of work, astronomical, geodetic, hydrographic, and geologic, as well as the strictly seismologic, that formed a part of the cooperative scheme, and outlined the parts taken by the various agencies doing this kind of work. Among the new instruments used in this investigation he mentioned the Anderson-Wood torsion seismometer and the sonic sounding device of the Navy Department. He concluded by saying: "Such a number of vigorous agencies, thus brought together, cannot fail to accomplish a great deal more than any one could do alone; such a representative group of agencies, I believe, cannot fail of success." President Day's address is published in full in *Science*, **61**: 323. March 27, 1925.

Following a brief intermission after the address, the annual business meeting of the Academy was held. The minutes of the 26th annual meeting were read and approved. The Corresponding Secretary, Francis B. Silsbee reported briefly on the activities of the Academy. During the year 35 persons were elected to regular membership, and Dr. Sigurd Orla-Jensen of Copenhagen to honorary membership in recognition of his work in bacteriology. Eighteen resignations were accepted during the year, of whom 7 were resident members, and 5 were dropped for non-payment of dues The ACADEMY lost by death the following 9 members: ALFRED H. BROOKS, JOHN T. HEDRICK, NED HOLLISTER, F OMORI, J. J. STEVENSON, A. W. VOGDES, WOODROW WILSON, E. V. WINCHELL, and R. S. WOODWARD.

During the year the Board of Managers held four meetings In addition to attending to routine business and the election of new members, the Board adopted a resolution in support of the project for a National Arboretum, and designated respresentatives to the International Mathematical Congress at Toronto, to the Centenary Celebration of the Franklin Institute at Philadelphia, and to the Washington meeting of the American Metric Association

The report of the Recording Secretary, WALTER D LAMBERT, was read There were held during the year 9 public meetings, most of them jointly with one or more of the affiliated societies, at which addresses were delivered The names of the affiliated societies participating, the names of the speakers, the titles of the addresses, and occasional items of interest in connection with them were given.

The report of the Treasurer, R. L. FARIS, showed total receipts of $5,579 86, and disbursements of $4,227 56, with a balance in bank on Dec 31, 1924, of $3,140 80. The value of the ACADEMY'S investments was $16,036 37, and the estimated net worth including all items was $18,669 14.

The report of the auditing committee, consisting of WHITMAN CROSS, G M. COLLINS, and O. S ADAMS, was read, which verified the Treasurer's figures. The reports of the Treasurer and of the auditing committee were then accepted

The report of the editors of the JOURNAL was presented by the senior editor, E P. KILLIP. Figures were given regarding the number of articles and their distribution among the various branches of science The general form and policy of the JOURNAL was substantially as during the previous year

The Committee of Tellers reported that the following officers had been elected for 1925, *President*, VERNON KELLOGG, *Non-resident Vice-Presidents*, J. STIEGLITZ, WILLIAM WHEELER, *Corresponding Secretary*, FRANCIS B SILSBEE, *Recording Secretary*, WALTER D LAMBERT, *Treasurer*, R L FARIS, *Managers, Class of 1928*, E C. CRITTENDEN, G W McCOY

The following Vice-Presidents nominated by the affiliated societies were then elected: *Anthropological Society*, TRUMAN MICHELSON; *Archaeological Society*, WALTER HOUGH, *Bacteriological Society*, W M CLARK. *Biological Society*, S. A ROHWER, *Botanical Society*, H. L SHANTZ, *American Chemical Society, Washington Section*, LEASON H ADAMS, *Entomological Society*, A. G. BOVING; *Washington Section, Society of American Foresters*, GEORGE B. SUDWORTH, *National Geographic Society*, FREDERICK V. COVILLE, *Helminthological Society*, B. H. RANSOM.

195th MEETING

The 195th meeting of the ACADEMY was held jointly with the Anthropological Society, the Archaeological Society, and the Biological Society in the auditorum of the Carnegie Institution Building the evening of Tuesday, January 20, 1925. It was devoted to a symposium on *The origin and evolution of man*. President JOHN C. MERRIAM of the Carnegie Institution spoke on the geological aspects of the evidence and the significance of evolution for the future.

There is need to increase the knowledge of what we are by learning how we came into existence and what are the nature and sources of our characters and what is their possible future development. The problem of the evolution of man includes three questions. (1) the history and evolution of man from his origin to the present time, (2) the problem of the evolution of man from a possible ancestral type, (3) the future course of development of the human race. Will it represent evolutionary progress? In general the problem of the evolution of man is part of the larger question of evolution of the whole organic world and can be understood or interpreted mainly through study of this question as a whole We approach the general problem of evolution from the point of view of comparative anatomy, of embryology, of experimental evolution, and of historical development The question of historical development is understood only through the approach of geological history, which must itself be interpreted through an understanding of the geological record An understanding of the meaning of time involves, first, the interpretation of local sequences of strata, and second, fitting together those fragments of the geological record scattered over the whole world which together represent the time sequence as we know it The paleontological record is read from this volume 1. Change. 2 Not repeat 3 Definite direction 4 Apparent overlap or connection of members of the sequence. One of the most important features in the story of man is that the earlier chapters are read from the geological record and not from documents of entirely recent or historical origin

Does the point of origin indicate derivation of man from an ancestral non-human type? Yes Man appears at the right time and with the physical characters that we would expect if he were derived from a non-human type by modification. What is creation? Making of something new out of pre-existing materials Does man's history show changes in physical types? Yes Advance in brain type? Yes. Will the future probably bring new and more advanced types of man? Yes, unless the myriad centuries of evolution of the organic world have led to halting of evolution only when an organism becomes intelligent Intelligence should lead us to choose the best path of evolution and we believe it will (*Author's abstract*)

The next speaker, Dr ADOLF SCHULTZ, spoke on *The embryological evidence of the evolution of man* His address, under that title, is published in full in This JOURNAL, vol 15, June 19, 1925.

The concluding speaker was Dr. ALEŠ HRDLIČKA of the U. S National Museum, who spoke on anthropological explorations in connection with the problem of evolution

The addresses were illustrated with lantern slides.

196th MEETING

The 196th meeting was held jointly with the Geological Society of Washington in the assembly hall of the Cosmos Club on the evening of Wednesday, January 28th Professor FREDERICK J PACK of the University of Utah spoke on *Some scenic aspects of Utah geology*.

Dr HUGH D MISER of the U S. Geological Survey spoke on *Erosion in the San Juan Canyon, Utah*

The canyon of San Juan River extends west across a high arid region in southeastern Utah and joins the Glen Canyon of Colorado River near the southern boundary of the state. It reveals a magnificent geologic structure. There is section possession of the same dimensions as the canyon, as much as half a mile high and 133 miles long. The rocks aggregate a thickness of 5,000 feet and consist of limestone, sandstone, and shale, ranging in age from Pennsylvania to Jurassic. Most of the rocks are red beds, and, since soil is scanty and rock ledges abound, red is the predominating color in any landscape view. The rock strata have been flexed into a broad gentle arch, but neither the arch nor the minor structural features, such as anticlines, synclines, monoclines, faults, and joints, have influenced the course of the river. The present crooked course of the river in the canyon is a striking example of an entrenched meandering stream Such a course may have been developed on a former cover of Tertiary sediments or on a peneplain, fragments of which stand near and above the walls The peneplain is possibly of Pleistocene age, and the canyon cutting therefore apparently began in Pleistocene time The cutting was rapid but did not continue uniformly as there were a few short pauses when the river was graded and deposited gravel which now floors benches of small area on the walls. Rock debris, consisting of sand, gravel, and boulders, forms the bed of the river and attains a depth of perhaps 100 feet or more But it is presumably absent in a few of the rapids that are produced by inclined ledges of hard rock which cross the channel Long stretches of the canyon, where the debris is deepest, present the peculiar example of an alluvial stream flowing between close walls of solid rock, but much of the debris is apparently moved by high floods that take place many years apart.

The San Juan River carries an unusually large quantity of debris for streams in the United States and it is one of the chief contributors of mud to Colorado River The water is always muddy, but during flood stages the river is actually a river of mud, and according to samples taken by Pierce it occasionally carries by volume three times as much silt as water The heavy load of debris carried during floods causes a peculiar kind of waves known as sand waves These waves attain a height of about 7 feet and resemble those thrown up by a stern-wheel river steamboat They travel upstream, in marked contrast to other kinds of waves that are stationary and also to waves that travel downstream

If the proposed storage and power projects on San Juan and Colorado rivers are carried to completion the river, on reaching the heads of the reservoirs, will change its work from erosion to deposition An important question concerning the reservoirs is, How soon will they be filled with rock debris? The answer to this question remains for the future, because the data available at present are not sufficient for making an estimate of the total load of debris that is carried each year by the San Juan and discharged into the Colorado. (*Author's abstract*)

Both papers were illustrated with colored lantern slides.

197th MEETING

The 197th meeting was held jointly with the affiliated biological societies of Washington in the assembly hall of the Cosmos Club on the evening of February 19, 1925. A group of papers was presented on the general subject of *Undesirable Immigrants*. Dr. J R MOLLER treated the subject from the standpoint of *Animal Diseases*, under the title *Foreign Insects a Menace*

It is to the interest of this country to prevent the introduction of contagious diseases, whether of humans, of other animals, or of plants. Within the past year there have been two examples of the great economic loss which may result from the inroads of foreign pests and of the danger to some of our greatest industries The outbreak of foot-and-mouth disease among the livestock of California and Texas, was the concern of the entire country and Congress acted promptly in appropriating money to combat it This plague of livestock is so contagious that the United States Department of Agriculture takes every precaution against introduction, even to prohibiting experimental work with the disease in this country.

In spite of all precautions the virus of a dangerous disease sometimes gets by the barriers maintained by the Bureau of Animal Industry. The exact method by which the recent foot-and-mouth disease gained entrance is not known The introduction of virus of the European fowl pest, which appeared in poultry flocks of this country last December, is of peculiar interest, because of the probable method of its introduction This disease had not been known in the United States and precautions were taken against its introduction, but it has been found that an investigator working on filterable viruses in a large eastern institution obtained the virus of the European fowl pest, in the summer of 1923, from the Pasteur Institute of France Dr. JOHN R. MOHLER, Chief of the Bureau of Animal Industry, says there is a possibility that the disease was introduced through some other channel, but that this is the only known source of this virus, and that the disease was first found in States where work with the virus was done The Department of Agriculture does not permit the importation of animals from countries having destructive animal diseases not already present here. It is very rarely that a dangerous disease gets past the barriers that have been raised to exclude livestock diseases. There have been several outbreaks of foot-and-mouth disease in the past 40 years which have been stamped out by the bureau veterinarians There have been a few outbreaks of other animal diseases foreign to this country, including the present outbreak of the European fowl pest Only those well acquainted with disease conditions throughout the world know what we have probably escaped by maintaining quarantine walls and by sending inspectors into foreign countries (*Abridged from author's abstract*)

Dr THOMAS E SNYDER of the Bureau of Entomology treated the subject from the standpoint of plant diseases and insect pests, under the title *Forest insect pests and their control*

Col. GREELEY has referred to the great destruction of forest trees by barkbeetles and defoliating insects and emphasized the importance of forest management in their control There are other types of forest insects which cause an annual loss of forest products estimated at $40,000,000 To this loss must be added percentages of the cost and upkeep of lumber camps, machinery, equipment, logging railroads, wages and keep of men and animals in the woods, storage in the mill pond, sawing, drying, finishing and piling at the mill. Where the products, such as telephone poles, construction timbers, etc., are damaged after being put in place, the cost of replacement involves losses of labor and time, as well as the cost of the original and replaced products. The control of these insects is an important factor in forest conservation The losses they cause can be greatly lessened by slight readjustments in logging operations, mill management, closer utilization and the use of wood preservatives. (*Author's abstract*)

Dr. LAWRENCE KOLB of the Hygienic Laboratory treated the subject from the standpoint of *Human diseases*

The addresses were illustrated by lantern slides and moving pictures.

WALTER D. LAMBERT, *Recording Secretary.*

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GEOPHYSICS.—*The part played by isostasy in geophysics and geology.*[1]

WILLIAM BOWIE, U. S. Coast and Geodetic Survey.

It was about a half-century from the time that the idea of isostasy was advanced by Airy and Pratt until there was undertaken a quantitative test of sufficient magnitude to prove or disprove the theory. It was very fortunate that we had in the United States a geodetic problem which had to be solved in the interests of surveying, charting, and mapping. This problem was the placing of the triangulation of the United States on a single spheroid and relating it to a single initial station. The testing of isostasy proved to be an incident in this work.

Prior to the time when the late Dr. John F. Hayford assumed charge of the geodetic work of the U. S. Coast and Geodetic Survey, 27 years ago, there were not sufficient connected triangulation and astronomic data to make possible the placing of the triangulation system of this country, which is the basis for surveys, maps and charts, in its correct relation to the meridian through Greenwich and the plane of the equator. Shortly after Hayford took charge of the geodetic work, the readjustment of the separate arcs of triangulation in a single network was begun. The result of this work was the adoption of what is now called the North American Datum. This datum may be defined as the Clarke spheroid of 1866, a latitude and longitude for the initial triangulation station, Meades Ranch, in central Kansas, and an azimuth from that station to the triangulation station Waldo.

Hayford had available a sufficient number of astronomic stations to make the adjustment of the triangulation to the single datum and he soon learned, from an inspection of the data, that it would be possible

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[1] Presidential address before the Philosophical Society of Washington, January 8, 1927. Received January 26, 1927.

to make a determination of the shape and size of the earth from the triangulation of the United States alone. In order that this might be done accurately, he had the astronomic latitudes, longitudes and azimuths observed at many more triangulation stations in the country.

It is well known that the method of determining the shape and size of the earth is to compare the values of degrees of latitude and longitude, as derived from astronomic observations, with those determined by triangulation. The difference between the astronomic and geodetic values are due partly to erroneous values for the spheroid used in the triangulation computations and partly to the errors of observations in the triangulation and astronomic work. There is also present in the data an outstanding difference due to the deflection of the vertical or station error which caused much trouble to those who had previously determined the figure of the earth. Hayford, who was familiar with the literature on isostasy, realized that there was a possibility of applying corrections to the astronomic data which might eliminate to a large extent that part of the difference between the astronomic and the geodetic latitudes and longitudes and azimuths which is due to the irregular configuration of the earth's surface and also to the irregular densities in the outer portion of the earth. He assumed, in his computations, various depths to which the irregular densities might extend. These depths varied from zero to 200 miles. He found, as a result of what he called his first investigation, a limiting depth to these irregular densities and, therefore, to the crust, of 113.7 kilometers. A second investigation, in which considerably more data were used, resulted in a derived depth of the crust of 122.2 kilometers. Later an extensive test of isostasy was made by the use of gravity data, and this supplemented and greatly strengthened the conclusions reached from the deflections of the vertical. From the gravity data the best value for the depth of the earth's crust is 95 kilometers. An inspection of Hayford's work indicated that his depth of compensation derived by the use of deflection data in mountain areas only was 97 kilometers. It was thought that a mean of these two values, 96 kilometers, is the best depth and it has been generally adopted by geodesists, although seismologists are inclined to favor a depth of approximately 60 kilometers and many geologists are of the opinion that 60 kilometers most nearly agrees with available geological evidence. We do not know just why there should be a limiting depth to the outer portion of the earth having residual rigidity, but that there is a change in physical characteristics near the 60-mile depth is undoubtedly true.

It was assumed in both the gravity and deflection computations that the compensation of the topography, by deficiency of density under land areas and excess of density under the water areas, is distributed uniformly from the surface to a limiting depth. This, of course, is an artificial assumption, for it is rather difficult to see how there could be any uniformity, except in a most general way, in the distribution of the deficiencies and excesses of density. It is certain that the differences from normal could not start right at the surface of the solid earth as was assumed, nor that they broke off suddenly at a certain depth below sea level. Innumerable assumptions may be made in regard to the distribution of deficiencies and excesses with depth, but the chances are that no two investigators would agree on an assumption. We may however regard the uniform distribution as practically a mean of all of the possible distributions, and, therefore, as probable as any. It has been found, by test computations, that the gravity anomalies can be reduced just about as well by assuming that all of the isostatic compensation is distributed in a thin layer at a depth of about 30 miles below the earth's surface as by having the compensation distributed uniformly. This simply means that no matter what the distribution, we must have the center of gravity of the compensation of approximately 30 miles below sea level. It would be interesting if we could learn the actual distribution of the deficiencies and excesses that balance the topography, for we then might be able to interpret the past history of the earth with more success than is now possible.

The testing of isostasy by the U. S. Coast and Geodetic Survey has been supplemented by that of investigators in other countries. India has taken a leading part and a number of tests have shown that its area is in equilibrium. This has also been found to be true for Spain, Holland, Norway, southern Canada and the Mackenzie Basin. The region around certain islands in the southern Pacific has been found to be in equilibrium. (This Pacific work was made possible by a grant of funds by the Philosophical Society of Washington.) Wherever land areas have been tested the prisms of the crust below have been found to be in isostatic equilibrium.

During the last few years gravity observations of a rather high degree of accuracy have been made at sea on a submarine by the use of a special pendulum apparatus. The instruments were designed and the method devised by Dr. Vening Meinesz of the Dutch Geodetic Commission. It is a long step forward in geodetic work to have a means of determining gravity at sea and data of great value can now be collected over the oceans by the submarines of many countries. This is a peace-time work for the submarines that should have much value in theoretical science and might, eventually, have a profound influence on industry. Much of the wealth of a nation depends on what is in the earth below its area. We can only discover what is in the earth and how to utilize it by means of geological or geophysical investigations and it is certain that isostasy will be a factor in these endeavors.

It is well known that for the first mile and a half of the earth's crust the temperature increases at the rate of about 50°C. per mile. We do not know what is the temperature gradient lower down, but it is safe to make the assumption that this rate of increase is maintained for some miles below the earth's surface. Much has been written on the heat of the interior of the earth but it is not necessary to do more than touch on this problem here. The pressure on the earth's materials increases with depth to enormous proportions. Is it not possible that the change in the character of the earth's materials from one of residual rigidity to one of practically no rigidity is due to the increased heat and pressure near the depth of compensation, approximately 60 miles below the earth's surface?

Reductions of a number of Dr. Meinesz' gravity stations at sea have been made by the U. S. Coast and Geodetic Survey. There is an indication that gravity over the Atlantic and the Pacific is, on an average, greater than gravity at sea level over the land. After the reduction for topography and compensation has been made for the sea stations there is an outstanding average positive anomaly. This positive anomaly might be due to each of several causes or a combination of two or more of them. First, it might be due to a lack of accurate information as to the configuration of the ocean bottoms for a hundred miles or more around each of the stations. This, however, does not seem to be a very fruitful source for discovering the cause of the anomalies, for a lack of definite information would tend to give both positive and negative anomalies about equal in number. The lack of definite suboceanic topographic data would be accidental in its effect.

The second cause for the positive anomalies might be an actual departure of crustal prisms beneath the ocean from the perfect isostatic condition. This, however, does not seem to be a very probable cause. The earth's crust has been formed for a billion years or more and the central portions of the ocean basins have been less disturbed by erosion and sedimentation than have the land areas; therefore, the crust beneath the central parts of the ocean is likely to be more nearly in equilibrium than elsewhere. The prisms of the crust under the oceans have had sufficient time to bring about complete isostatic adjustment among themselves and with respect to continental areas.

The third cause for the positive anomalies may be the irregularities in the geoid surface. Over the oceans, with isostasy practically perfect everywhere, the geoid surface should be and probably is closer to the center of the earth than are points at sea level on land areas in the same latitudes. In a given latitude the value of gravity increases toward the center of the earth down to a certain distance below sea level. On the other hand it decreases with elevation above the surface of the earth. A change in elevation of ten feet makes the computed value of gravity one part in a million greater or smaller. Gravity values are reduced to the geoid because we do not have sufficient data to determine the relation at any particular point between geoidal and spheroidal surfaces. A computation was recently made at the office of the U. S. Coast and Geodetic Survey by C. H. Swick which showed that, in the middle Atlantic the geoid is approximately 8 meters below the spheroid or to put it in another way, using the spheroid as a datum, the geoid is 25 meters lower than at a certain point in the Appalachian mountains in South Carolina to which the computation was referred. Such a difference in the elevation of the geoidal surface in relation to the spheroid should make a difference in the value of gravity of about 8 parts in a million. The effect on gravity of the depression of the geoid over the ocean areas would seem to be systematic and the average gravity anomalies over the oceans should, for any large area and large number of stations, tend more to be positive than the average anomalies over large land areas.

The factors in the gravity formula by means of which we obtain the gravity at sea level at any latitude are based on the values of gravity observed over continental areas. Necessarily, since in this area the geoid is above the spheroid, the values of gravity are too small. It would seem that a gravity formula to be used for both land areas and oceans should be based on observed values well distributed over land and water. Then, if we knew the deviation of the geoidal from the spheroidal surface, we could apply negative corrections to the computed values over the land areas and positive corrections to the values over ocean areas. Then, the resulting mean anomalies with regard to sign would be approximately zero for any large group of stations, whether on land or water.

The question of the reduction of gravity stations to the geoidal surface rather than to the spheroidal is a matter that needs to be investigated further with a view to learning just what the gravity anomalies at stations at sea, which tend to be positive, may mean in terms of isostasy.

There is another cause for outstanding anomalies at sea just as for large anomalies on land; that is the presence of material that is abnormally heavy or light in density close to the gravity station, both horizontally and vertically.

It would seem from the results of gravity observations taken at sea that isostasy in the crust under the oceans is approximately as complete as under the land. After all corrections have been applied to the computed values, including the reduction to the spheroidal surface, the remaining anomalies would on an average be quite small as compared with the effect of a deficiency of crustal material equal to the difference between the mass of ocean waters and a mass of surface rock of equal volume.

It seems necessary to conclude from the proof of isostasy that the isostatic adjustment or transfer of material from the base of a prism of the crust that is being depressed by sediments to the base of a prism of the crust that is undergoing erosion must take place below the crustal material. The material of the crust itself has residual rigidity and maintains its form for geological time. It is, therefore, too strong to permit of horizontal flow as a result of disturbance of the isostatic equilibrium. Besides, this material has apparently maintained through a long period of geological time, different densities in columns extending approximately 60 miles below sea level. There is a stress difference from high areas towards the low areas of the earth's surface until the depth of compensation has been reached where the stress difference is practically zero. Therefore there could not be in the upper part of the crust any horizontal movement of material from the sedimented area towards the area that is being eroded.

The principle of isostasy is a proof also that the earth's crust is exceedingly weak. No definite dimensions can be given to the mass of material that can be held up by the earth's crust without isostatic adjustment but a test has been made which throws some light on this subject. Of the more than 300 stations of the United States, 42 having elevations of 1000 meters or more were selected for the test. For each of the stations, corrections were applied for the topography of the world and for the compensation of all of this topography except for a disk directly under the station extending horizontally to a distance of 17.9 miles. The result of ignoring that compensation was to make all of the stations have negative anomalies, except 4, and the average anomalies with and without regard to sign became −0.037 and 0.040 dyne.

This, it seems, is an indication that we cannot ignore in our gravity reductions the compensation of even such small amounts of topography without having the anomalies bear a definite relation to the elevation of the station. A second test was made with these stations by ignoring the compensation of the disk of topography extending to a distance of 36.5 miles in all directions from the station. In this case all of the anomalies except one became negative and the mean values, with and without regard to sign, became −0.072 and 0.072. It is certain that a disk as large as 1000 meters in thickness and 36.5 miles in radius is largely compensated and it is probable from the two tests that a disk much smaller than 1000 meters in thickness and 17.9 miles in radius does not escape compensation entirely. These tests seem to give some idea of the masses which the earth's crust cannot withstand as extra loads.

Since the earth's crust is so weak as not to withstand the loading and unloading caused by sedimentation and erosion, we must conclude that some of the geological theories that are based on the idea of a very rigid crust, carrying horizontal thrusts for hundreds and even thousands of miles, must be modified or abandoned. In this particular, it would seem that isostasy has its most important bearing. Isostasy in itself is not an active agency; it is a condition of rest and its proof leads to the logical conclusion of a very weak crust and thus restricts the field within which hypotheses and theories may be formulated to account for surface changes.

There are two ideas of isostasy, one advanced by Airy and the other by Pratt. The Airy idea postulates a rather uniform density of crustal material or at least a density that varies the same along all radii. That view requires a greater thickness of crustal material under continental and island areas than under water areas. This theory seems logical until we inquire into the cause of mountain uplift and of the formation of synclinoria. The advocates of the Airy idea claim that the thickening of the crust is due to a crushing and distorting of crustal material beneath areas which have undergone heavy sedimentation. They hold that the crust beneath such areas is weaker than in other places. The horizontal forces causing that crushing are supposed to have their origin either in the collapsing of the non-cooling crust on a cooling interior, or to an expansion of the crust due to radio-activity without any change occurring in the volume of the nucleus, or to a collapsing and buckling of the crust on a nucleus which is being compressed by the overloading of the crustal material. Any one of these processes may be going on but it is quite certain that, should there be great horizontal forces carried through crustal material, the deepest parts of the ocean would be the ones to buckle up rather than areas of erosion, the surfaces of which are close to sea level. On the Airy hypothesis the crustal material under the oceans must be very much thinner than under continental areas and therefore the first to yield.

The Pratt hypothesis calls for a uniform depth of crust with material of different densities in the prisms under surfaces of different elevations. If we assume normal densities for the crustal material under the coastal plains then we must assume a lighter material under the plateaus and mountain areas of the continent and a heavier material under the oceans. One objection to the Pratt hypothesis is that changes in density of crustal material, greater than those caused by ordinary thermal expansion, must be taking place when an area once at or close to sea level is thrust upward into a plateau or a mountain system. If the mountains are three miles high on an average, which is approximately that of the Himalayas, the Pratt hypothesis requires a 5% increase in volume and decrease in density in the prisms of the crust below. This is on the assumption that the crust extends to a depth of 60 miles below sea level. On the other hand, if a synclinorium is formed where previously there was an area of uplift and erosion, we must assume on the Pratt idea a greater contraction of the prism of the crust beneath, than could be caused by normal thermal contraction, and a decrease in volume. The usual thermal expansion or contraction is not enough to account for the major uplifts and depressions.

The Airy hypothesis and also many of the old hypotheses which are based on a collapsing crust, must seek some interior cause of the major movements of the earth's surface. With the Pratt hypothesis, on the other hand, erosion and sedimentation seem to be all that is needed to start the sequence of events which change the surface configuration.

An enormous quantity of water has fallen to the earth's surface during the geological period. The average annual rate of rainfall is about 30 inches for the land areas of the world. At that rate there would be approximately a mile of rain in 2000 years or somewhat more than a half million miles during the sedimentary age which is generally supposed to be about 1½ billion years long.

The rate of erosion for the United States as determined by the U. S. Geological Survey is equivalent to one foot of material over our 3,000,000 square miles of area in 9000 years. At that rate, there would be a mile of erosion in about 45,000,000 years. The sedimentary age is more than 30 times that long. This indicates what a tremendous amount of work has been done on the earth's surface in transferring material from one place to another. The amount of erosion in any one area would not of course be as much as 30 miles in thickness, due to the fact that an area is base leveled long before any such amount of material can be carried away. On an average, however, erosion may have aggregated something like 30 miles or more during the sedimentary age. Of course, some areas might have been above sea level undergoing erosion at one part of the age and during another part might have been below sea level receiving sedimentation. For this reason the erosion from any one area during the entire sedimentary age might have been only a fraction of the total amount of erosion which could have taken place in an area continuously exposed to approximately the same conditions now found in the United States.

Nearly all of the sediments derived from a continent go to shoal water and are deposited within about 100 miles of the shore. Only a small part goes beyond that limit. These sediments are deposited in a most irregular way. The mouth of any particular river may wander along the shore or change its position as the Yellow River did in 1852, shifting from the south to the north side of the Shantung Peninsula. The sediments deposited by a river will be deeper in some places than in others and the chances are that they will be the deepest not very far off the general coast line of the continent. Farther out to sea, they will gradually thin out. If the sediments are being deposited in an inland sea they will be thickest close to the shores of the sea. All mountain ranges seem to have been uplifted in areas which have previously been subjected to very heavy sedimentation. There seems to be a direct connection between sedimentation and mountain uplift.

As material is carried from elevated regions and deposited in lower ones, the isostatic balance is disturbed. The weight of the sediments depresses the crust beneath them, and the prisms undergoing erosion become lighter than normal. The result is that the crust in the area of sedimentation tends to sink and to force subcrustal material into crustal space, finally pushing up the lightened erosion prism. Eventually a balance is restored between the crust beneath the sedimentary area and the crust under the erosion area by movement of subcrustal material.

There is no such thing as a transfer of subcrustal material from below the crust where sedimentation is occurring to the space below the crust undergoing erosion. There is merely a pushing aside of crustal material as the sediments depress prisms and the result is a movement of subcrustal material all the way back to the area of erosion. The motion is similar to that which would occur in a pail of water, in which wooden blocks are floating, if one block is increased in mass and the other decreased. The water does not flow from one block to another but the whole liquid mass is readjusted. How far below the crust the distortion of subcrustal material may occur in the restoration of the isostatic balance is not known. It may be 10, 100 or even 1000 miles but probably the thickness of subcrustal material affected is not excessive.

If an area undergoing erosion should lose 1000 feet from the surface there will not be that much lowering of the area, for there will have occurred an influx of subcrustal material below the base of the prism to restore the isostatic equilibrium of the prism affected. The amount of lowering will depend on the relative densities of subcrustal and crustal material. If the difference in density is 10% then the surface would be lowered only 100 feet by the erosion of 1000 feet of material. It is thus seen that many times as much material can be eroded from an uplifted area before base leveling has been accomplished as there was in the original uplift. Of course uplift occurs gradually and as soon as an area begins to increase its elevation above the surrounding regions, erosion commences, so the mass of the original uplift is more or less a hypothetical quantity.

When an elevated area has been base leveled the source of sedimentation has been shut off and there is quiescence in the erosion and sedimentary areas. In a later geological period the former erosion area becomes a basin in which sediments are deposited. On the other hand, the former sedimentary area is uplifted and a mountain system or a plateau is formed from which erosion begins. There is thus a sort of oscillation between the uplifted and downwarped areas. Such areas have, no doubt, changed positions several times during the sedimentary age and will continue such changes in the future.

While there is much sedimentation in lakes and valleys, a great part of the material washed down from great elevation is carried to sea and deposited near the shores. Eventually a belt of sedimentation 100 miles or more in width is extended along the whole waterfront of a continent. Later this material is raised up into a plateau or mountain system and then erosion from it occurs. Part of the eroded material will work inland, possibly to the regions from which the sediments came, but much of it—probably at least half—is carried out to sea. Thus there is ever a tendency for the continental area to encroach on the ocean area. The process might be exceedingly slow and still be considerable in amount during a long geological period. We have no available evidence to show just what were the original limits of the continental areas. In the continental areas should probably be included areas along the shores out to the edges of the continental shelves. The continental areas are much larger when thus considered. The sediments that are carried to sea force subcrustal material back towards the areas of erosion. As the density of sediments must be from 10% to 20% less than that of the subcrustal material the thickness of the sediments must be that much greater than the thickness of the subcrustal matter displaced and a gradual filling up of the ocean areas must be taking place.

It seems certain that the earth's surface was very irregular before the beginning of the sedimentary age. This is indicated by the heavy elements found in greater percentages in the igneous rocks on the ocean islands than in the igneous rocks on continents. The specific volumes of these igneous rocks for land areas are greater than for the lavas under the ocean areas. It seems probable that the earth's crust was in equilibrium before the beginning of sedimentation and, if so, then owing to the variation in the specific densities of the igneous rocks composing the crust, there should have been some areas standing at higher elevations than others. When water began to fall to the earth, it collected in the low areas to form oceans and inland seas. The weight of the water then disturbed the isostatic equilibrium of the crust and caused a readjustment by the movement of subcrustal material from below the water areas towards the land areas.

I am assuming that, prior to the sedimentary age, the earth's surface was too hot to permit water to fall on it and remain there. This may not have been the real condition of affairs, for water may already have been on the earth with the atmospheric conditions such that there were no evaporation and precipitation to cause water to run over the land areas. In any event there was a time when rain began to fall. Without running water over land areas there could have been no erosion and sedimentation. It would be rather difficult to see how the processes which have been going on to cause the irregularities in the earth's surface could begin to operate if the surface were perfectly level at the beginning of the sedimentary age. The earth must have become quite cold, if it were ever in a molten state, by the time that the sedimentary age began, and any instability, due to internal causes, would certainly have been eliminated before the earth had cooled to the point where water could remain on its surface.

Owing to the fact that the earth's crust is now in isostatic equilibrium, and that it probably has been so for all of the sedimentary age and even for a long time prior to the beginning of that age, we must conclude that the strength of the crustal material is very low. It will yield or break under the gravitational forces resulting from the accumulation of sediments or the unloading of an area by erosion. A crust so weak as to remain in isostatic equilibrium is not competent to carry thrusts through great distances such as are required in the collapse hypothesis. Many who held to that hypothesis prior to the establishment of isostasy, now believe in what is generally called the "roots of mountains" theory which, in effect, is the idea of isostasy as first advanced by Airy.

In order that crustal material may extend into subcrustal space in the form of roots to balance the masses above sea level, it would have to be extremely weak under the uplifted areas. If the normal thickness of the crust were 50 miles and if the difference in density between the lower crustal and the subcrustal matter is 15 per cent then the extension of the crust into subcrustal space under an uplifted area having an average elevation of two miles would be of the order of 15 miles. The crustal material under the elevated region would have been tremendously distorted to have a 50-mile thickness increased to approximately 70 miles. Even though there were a weak place in the crust, under the sediments which had been laid down prior to the uplift, this part of the crust would have been thickened materially shortly after the uplift began. Then, instead of a thickness less than normal, there would be one greater than normal, and the result of continued distorting of the crustal material to the sides of the area affected would be to buckle up the crust off to the sides of the area which had previously been one of sedimentation. Of course, the beginning of the movement of uplift and of depression of a root might have heated up the prism of the crust and thus made it weaker than normal but it seems to me that the mechanics of the "roots of mountains" theory are not very sound.

There is another weakness in the roots theory. The material of the roots which was weak enough to be crushed, distorted and pushed down into subcrustal space against the hydrostatic pressure of the subcrustal material, would seem to be too weak to maintain its new position for a long geological time against that hydrostatic pressure. Material cannot be both strong and weak and, if the roots can be formed by the weakness of the crustal material, they cannot be strong enough to maintain themselves against the gravitational forces exerted against them.

The proof of isostasy and the consequent weakness of crustal material force us to the conclusion that the major changes in surface elevation must be due to a change in volume of the crustal material directly below the affected areas. The isostatic investigations have shown that the most probable depth to which the crustal material extends is about 60 miles. The temperature gradient found from measurements of temperatures in wells and mines is approximately 50°C. per mile. The gradient varies greatly from place to place, but this is a fair average. We may assume then a temperature gradient of about 1°C. per 100 feet. If the earth were maintained in isostatic equilibrium to a very high degree of perfection, then as sediments were deposited along the coast or in lakes or valleys, the crust would sink down under the added weight. It is not known just how thick the sedimentary beds must be before there is an isostatic yielding of the crust below but if, say, a hundred feet of sediments causes an adjustment, then each element of the crust below would be pushed down nearly one hundred feet into regions which are about 1° hotter than the space they formerly occupied. While sedimentation progresses at a rather slow rate yet the conduction of heat through rock is supposed to be even slower.

The normal thermal expansion of a prism of rock 60 miles in length per one degree Centigrade is about 10 feet. The coefficient of expansion on which this calculation is based is that of marble. For a thousand feet of sediments the change in temperature due to the isostatic yielding of the crust might result in a subsequent uplift of 100 feet. It is believed that many of the small vertical oscillations of the surface of the earth have been caused by the thermal expansion and contraction of the crustal material after it was pushed down under sediments to hotter regions or raised to colder regions by isostatic adjustment following erosion.

The maximum thickness of sedimentary beds for any one period is generally believed to be about eight miles, approximately 40,000 feet. The expansion of the crustal material depressed eight miles due to thermal change would be about 4000 feet. That is, the surface would be raised approximately that amount when the depressed crustal material had taken on the temperature normal to the new position. But 4000 feet is a small elevation, as compared with what we have in many mountain regions. The Himalayas have a maximum elevation of about 29,000 feet while the average elevation is close to three miles. The Andes have an average elevation of about three miles. We therefore must look for some cause other than thermal contraction and expansion of crustal material to cause surface changes. By a process of elimination we are forced to conclude that a change of density and volume is brought about by chemical or physical processes in addition to that caused by thermal expansion and contraction. Just how this occurs it is impossible to say, but there are numerous cases of two minerals having exactly the same chemical composition but different volumes and densities, a notable example being diamonds and graphite. Both are pure carbon, but the diamond has a density of 3.52 and the graphite only 2.25. The difference is about 36% of the density of the diamond. It may be that there is some rearrangement of the elements as a result of changes of temperature and pressure which would cause a change of density of 3% in the prism of crustal material, and that is sufficient to raise the surface as much as two miles.

We have no proof that expansion and contraction actually take place in the earth's crust but a careful consideration of the mechanics of the earth seems to make these the most probable causes of surface changes. Opposition to this explanation of surface changes has been raised by a number of students of the earth because of their difficulty in explaining on this basis the great horizontal movements which have occurred in the material near the earth's surface. Undoubtedly there have been extensive horizontal movements but the writer maintains that these can be explained more easily on the theory that they are incidental to the vertical uplift rather than that they are the major movements and that the vertical movements are incidental. In practically all cases where a horizontal movement has been detected in exposed strata, the thickness of the strata involved was small; probably one or two miles is about the maximum thickness of material that has been overthrust for any considerable distance. Usually the thickness of material involved in the overthrust is a half mile or less and in some cases only a few hundred feet. It is difficult to see how a thin veneer of stratified rock could be moved horizontally for the many miles that some have estimated the movement to be. The moving material must overcome frictional and shearing resistances and if the uplift is due to the action of regional forces the overthrust material must be pushed uphill for it is in this direction that the movement would occur according to the collapse hypothesis.

On the collapse hypothesis the crust that is weak enough to be distorted by the action of horizontal forces carried through long distances must be strong enough to push up a mountain system and to force down into subcrustal space sufficient material to form a root that will support the mass which is above sea level. These horizontal forces, presumably, would be acting through the whole crust rather than merely in the outer layers. I cannot conceive of blocks of material a mile or two in thickness being pushed overland distances of 10, 20 or more miles as seems to be required to explain certain cases of overthrusting. Of course, it is difficult to explain an overthrust of 50 miles on any hypothesis and the isostatist has little or nothing to suggest, except that the field evidence regarding the overthrusting and the extent of horizontal movements in general may have been somewhat misinterpreted. One is likely to see in data those things which support the views that are considered authentic. It is my belief that as much evidence, probably more, could be collected in the field in favor of the vertical uplift theory as may be obtained in support of the view that the horizontal movement is the predominating one.

It is probable that the direction of the overthrust and of much of the horizontal movement of material is from the center of the uplifted mass outward towards its edges. If this should be found to be true then the Pratt theory of isostasy would be much strengthened.

In Daly's recent book, The Mobile Earth, he mentions a block of material resting on the plains of Montana many miles to the eastward of the uplifted area from which it came. That is a clear indication that the overthrust was from the uplifted regions towards the low areas to the sides. When the direction of overthrusts has been discovered, we shall be able to make greater progress in the solution of the problem as to how the uplift occurs.

A Pratt isostatist naturally leans towards the idea of a very weak crust with expansion and contraction of crustal material as the major causes of surface changes in elevation. A belief in the Pratt isostasy leads one to think that earthquakes are the result of four major processes. An earthquake is generally accepted as being due to the breaking of rock. This rock must be within the crustal space for the subcrustal material is too plastic to break but instead it yields and conforms to changes without rupture. The crustal material itself must vary somewhat in plasticity as its lower limit is approached. The lower crustal material is under a tremendous load and movement in the lower half of the crust would be somewhat plastic with very little breaking of material. Seismologists have not yet determined with any degree of definiteness the depths at which the earthquakes occur, but the late Prof. Omori of Japan, who was recognized as one of the foremost seismologists of all time, claimed that he had not found any earthquake focus lower than 27 kilometers. I do not know whether his methods of determining the depth were adequate to secure exactness but his depths are very acceptable to the Pratt isostasists.

The four major causes of earthquakes would seem to be:

1st. The breaking of crustal material caused by the weight of sediments.

2nd. The breaking of rock as the crustal material is pushed up under an area of erosion to restore the isostatic balance.

3rd. The breaking of the rocks as the result of the expansion of the crustal material under an area which had previously undergone heavy sedimentation.

4th. The breaking of rock caused by the contraction of crustal material under an area which had previously undergone erosion during an extended time.

With the earth's crust in isostatic equilibrium, it is difficult to see how any material from subcrustal space could work its way through the entire crust and be exuded at the surface as a lava overflow. The pressure exerted by a column of liquid material extending from the earth's surface to the bottom of the crust would be enormous, and this pressure would be sufficient to fracture rock and make a lava overflow at some point whose altitude is much less than the top of a volcano. According to the Pratt theory of isostasy the overflow of lava from a fissure or from a volcano is probably caused by an expansion of the crustal material below. No extra mass has been added to the prism of the crust involved. It is merely a case of fluid material from some depth within the crust being raised to the surface, increasing the volume of the prism and decreasing the density. Whatever processes cause the uplift of a mountain system undoubtedly cause the volcano and the lava overflow.

It would seem that the earth is gradually losing heat as a result of erosion and sedimentation. As the eroded material is carried away the prism of the crust beneath is forced up to restore the equilibrium.

Erosion may have occurred to the extent of five or ten miles before an uplifted area is base leveled. In such a case every element of the crust beneath would have been raised to a position approximately equal to that distance and would have been brought to a region having a much lower temperature than that of the region from which it came. Eventually there would be a loss of heat at the surface and the material of the prism would be cooled down by 100° to 300°C., depending on how far the crustal material had been pushed up. That heat lost would not be compensated by any heat gained in other places. The areas of heavy erosion later become synclinoria into which sediments are deposited. The sediments accentuate the synclinoria resulting in a pushing down of crustal material into hotter regions. Eventually this material takes on the temperature of its new position, expands to form mountain systems or plateaus and again loses heat at the surface. What maintains the heat of the earth no one knows. There have been many theories, including the one now advocated by many that the disintegration of radioactive materials replaces heat in sufficient amounts to cause the surface of the earth to remain at a practically constant temperature. Be this as it may, we cannot escape the conclusion that the raising up of crustal material under areas of erosion brings hotter material to the surface with a consequent loss of heat.

It is rather difficult to see how a volcano could come into being out in the middle of an ocean but, in general volcanoes are merely a part of a region that is higher than the surrounding bottoms of the ocean. The Hawaiian Islands, for instance, occupy a long stretch extending for some 1200 kilometers while the average width of the pedestal on which the islands rest is of the order of magnitude of 140 kilometers. There must have been light crustal material where the islands now are at the beginning of the sedimentary age and the uplifts and subsidences of the Hawaiian area have been the result of erosion, sedimentation and to a certain extent of the accumulation of rock from coral growth. It is very difficult to explain a chain of islands out in an ocean without assuming under it crustal material which has been lighter than normal density from the beginning of the sedimentary age.

This brief sketch of the relation of isostasy to geological and geophysical problems is only the skimming of the surface of a tremendous problem. It is hoped that much thought and investigation by those interested in the subject will supplement the very meager data which we now possess.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

407TH MEETING

The 407th meeting was held at the Cosmos Club, October 28, 1925, Vice-president HEWETT presiding.

Program: C. K. WENTWORTH and E. T. APFEL: *A source-analysis of geologic literature on North America, 1921–22.*

N. H. DARTON: *Pre-Paleozoic surface of Arizona and New Mexico.*

R. S. BASSLER: *Mississippian rocks in northern Tennessee.*

408TH MEETING

The 408th meeting was held in the auditorium of the Interior Building, November 11, 1925, President STEPHENSON presiding. The Secretary announced the election to corresponding membership of W. A. NELSON, State Geologist of Virginia.

Program: A. H. REDFIELD: *Petroleum possibilities of Germany.*

H. S. WASHINGTON: *The 1925 eruption of Santorini.*

H. T. STEARNS: *The volcanoes of Japan in 1924.* In Japan and the islands nearby there are 74 active volcanoes which are aligned in narrow curved zones forming arcs that follow closely the crests of a series of great folds in the crust of the earth. It is generally supposed that the magma supplying the volcanoes exists in rifts or fissures that coincide largely with the axes of the folds. The chief volcanic zones are as follows: the Kurile, the Nasu, the Kampu, the Fuji, the Hakusan, the Aso, and the Kirishima zones.

The Kurile zone comprises a line of small volcanic islands which extends from Kamchatka to Volcano Bay on the southern side of the island of Hokkaido. Three eruptions on this zone during 1924 were recorded by a steamer. On February 15, 1924, a huge cauliflower cloud was seen rising from a volcano on Raikokejima, and at the same time two submarine eruptions occurred not far from Matau Island.

The Nasu zone extends from the islands a few miles north of Hokkaido through Volcano Bay to Fujiyama. During 1924 there were gaseous emanations sometimes accompanied by light ash falls from the crater of Asamayama on this zone. Parallel with and west of the Nasu zone is the Kampu zone. No volcanoes on this zone were in eruption during 1924.

The Fuji zone extends south from Fujiyama to the Bonin Islands. A small cinder cone in the center of the crater of Mihara, the central cone of the volcano Oshima located in the Bay of Tokyo, emitted huge volumes of steam during the writer's visit on December 16, 1924. At the same time heavy blue fumes were being discharged with a hissing sound at a high temperature. No glow from molten lava was visible in the daylight. The lava flow on the floor of the crater had not entirely cooled for heat rose from many cracks in its surface.

The Hakusan zone extends from Kyushu along the northern side of Hondo, the mainland of Japan. On January 23, 1925, Shiranesan (Kusatsu) located on this zone, emitted a huge volume of smoke and on the 24th, a heavy explosion occurred with loud rumblings, and ash fell over the surrounding area.

Aso-dake, on the Aso zone, which crosses Kyushu from northeast to southwest, had one explosion on January 9, 1924. On January 6, 1925, it again ejected ashes which caused damage to the farms at its base.

The Kirishima zone extends from Kirishima southwestward toward Formosa. Sakurajima was in repose during the writer's visit in 1924, although it was reported that a fumerole in the summit crater occasionally sent up a column of white steam. Kirishima volcano was not active during 1924, although on December 21, 1924, a hot fumerole inside of a small cone existed on the southeast wall of the summit crater. (*Author's abstract.*)

JOINT MEETING

A joint meeting of the Society and the WASHINGTON ACADEMY OF SCIENCES was held at the Cosmos Club, November 19, 1925, President KELLOGG of the ACADEMY presiding.

Program: Professor WILLIAM H. HOBBS, of the University of Michigan: *The glacial anticyclones—the poles of the atmospheric circulation.*

409TH MEETING

The 409th meeting was held at the Cosmos Club, November 25, 1925, President STEPHENSON presiding. The Secretary announced the death of J. K. HILLERS, a founder and active member of the Society, the resignation of L. B. PUSEY from active membership, and the election to active membership of E. R. POHL, GEORGE TUNELL, T. B. NOLAN, H. W. HOOTS, and P. G. NUTTING.

Program: C. E. RESSER: *Human and geographic aspects of the 1925 Smithsonian-Princeton Expedition to Europe.*

E. O. ULRICH: *European Paleozoic stratigraphy and stratigraphers.*

410TH MEETING

The 410th meeting was held at the Cosmos Club, December 9, 1925, President STEPHENSON presiding. Vice-president HEWETT took the chair during the presentation of the address of the retiring president. This address, entitled "*Major features in the geology of the "Atlantic and Gulf Coastal Plain,"* was printed in This JOURNAL (vol. 16, pp. 460–480).

THIRTY-THIRD ANNUAL MEETING

The thirty-third annual meeting was held at the Cosmos Club after the adjournment of the 410th meeting, President STEPHENSON presiding.

The annual report of the secretaries was read and approved. The Treasurer presented his annual report showing an excess of assets over liabilities of $1,137.49 (book value) on December 9, 1925. The auditing committee reported that the books of the Treasurer were correct. The Amendment to the Standing Rules restoring dues of active members to $2.00 was unanimously carried. The Society accepted, upon recommendation of the Council, the anonymous offer, through KIRK BRYAN, of three prizes of $10 each for excellence of presentation of papers during 1926.

The results of balloting for officers for the ensuing year was as follows: *President:* N. H. DARTON; *Vice-Presidents.* W. T. LEE, CHARLES BUTTS; *Treasurer:* J. B. REESIDE, JR.; *Secretaries:* J. D. SEARS, W. P. WOODRING; *Members-at-Large-of-the-Council:* B. S. BUTLER, S. R. CAPPS, G. R. MANSFIELD, O. E. MEINZER, C. N. FENNER; *Nominee as Vice-President of Washington Academy of Sciences representing the Geological Society:* L. W. STEPHENSON.

411TH MEETING

The 411th meeting was held in the auditorium of the Interior Building, January 13, 1926, President DARTON presiding.

Program: W. W. RUBEY: *Stream piracy in northeastern Wyoming.* Extreme northeastern Wyoming is drained by the Little Powder, Little Missouri, and Belle Fourche rivers. Little Missouri River, the central of the three, has the lowest gradient and field evidence indicates it has been and will be robbed by both the neighboring streams. The ancient capture of the headwaters of the Little Missouri by the Belle Fourche River at Stoneville Flats is well known. Old terraces and topographic relations seem to show that a tributary of Little Missouri River formerly flowed northwestward along the present course of Belle Fourche River between Stoneville Flats and Belle Fourche, S. Dak. This capture is attributed chiefly to foreshortening of the Cheyenne River as a result of the advance of Pleistocene glaciation, although the diversion of the lower Little Missouri River by an ice sheet had a slight additional effect Field evidence indicates that the resulting rejuvenation worked slowly upstream and that the capture may have occurred at about the end of the Pleistocene. Tributaries of Belle Fourche River will eventually divert the remaining headwaters of Little Missouri River.

The lithology of old gravels, the present stream gradient, and the land forms near the head of Belle Fourche River, and the sharp bend and terraces of Powder River suggest that the present Belle Fourche River formerly rose in the Big Horn Mountains, but was beheaded near Pumpkin Buttes by Powder River. This capture, which possibly occurred at the beginning of the Pleistocene, may be the result of greater precipitation in the Powder-Yellowstone drainage system than in the ancient Little Missouri system.

Little Powder River is preparing to behead the Little Missouri and perhaps the Belle Fourche River. The latter case of incipient piracy may be a readjustment following the capture at Stoneville Flats. (*Author's abstract.*)

KIRK BRYAN *The "Palouse soil" problem of the Columbia Plateau, Washington.* One of the conspicuous features of the Columbia Plateau is the mantle of soil which blankets the surface of the underlying rocks. The fine-grained unconsolidated material is in places 100 to 150 feet thick, and it is intimately dissected into hills by miniature ramifying valleys. Since this material is everywhere of about the same thickness and conforms to the general slope of the plateau, it is a natural assumption that it once formed a continuous cover and has since been dissected. With the assistance of a number of colleagues, somewhat scattered information about this so-called soil has been brought together and an analysis of the origin and age of the material made. In general the upper 3 to 6 feet of the material is a top skin or veneer that throughout the plateau is largely wind-borne. It rests on various sorts of material and the underlying mass that forms the inner core of the hills is generally unexposed and unknown. At various places there has been identified (1) laminated silt; (2) reddish compact silt with limy concretions, apparently an old loess, (3) yellow clay that microscopic examination shows to be an old loess; (4) ancient glacial till. In places in the eastern part of the plateau the yellow clay, or old loess rests on thin decomposed basalt but in the western part of the plateau the more sandy mass rests on nearly fresh basalt. Here below the general level there is a terrace covered by similar wind-borne soil in which the bones of an elephant were found. On this account, and in view of the association of the material with glacial till it is evident that the "Palouse soil" is of Pleistocene age.

A review of the known facts in regard to present dust storms indicates that these remarkable meteorological phenomena have been in operation only for the past few decades since the grass cover of the plateau was broken by ploughing. If the present rate of fall of dust as estimated for Spokane had been in operation since Wisconsin time there would be 16 inches of dust on the Wisconsin terrace whereas this terrace is free of dust. Similarly the pre-Wisconsin till plains and terraces (Spokane glaciation of Bretz) are almost free of dust. A still older till has a cover of 16 inches to 3 feet of loess and in other places the cover on the ancient till may be greater. Therefore, the time of formation of main loess ("Palouse soil") seems to be far back in Pleistocene time. (*Author's abstract.*)

LAURENCE LAFORGE: *The recognition of peneplains.*

412TH MEETING

The 412th meeting was held at the Cosmos Club, January 27, 1926, President DARTON presiding. The Secretary announced the resignation from active membership of MISS LUCY M. JONES.

Program: W. T. SCHALLER. *The mineralogy of the Tintic Standard mine, Utah.* The oxidation of silver-rich galena, silver-rich tetrahedrite, pyrite, and other sulphides, has yielded a number of unusual and rare minerals chiefly sulphates. Among these may be mentioned kornelite, ferropallidite, plumbojarosite, and argentojarosite. The plumbojarosite has formed, in part, directly from cerussite, but no evidence was seen that the argentojarosite had formed in any way but by the commingling of sulphate solutions of silver and iron. Some galena, partly oxidized to anglesite, forms a eutectic-like structure with it. Chains of orthorhombic sulphur crystals (similar to artificial ones) suggest paramorphism from earlier higher temperature monoclinic crystals. Rectangular casts suggest the one time presence of anhydrite. Most of the minerals mentioned probably formed from rather hot solutions. (*Author's abstract.*)

H. G. FERGUSON: *Regional relations of Nevada ore deposits:* The two-fold division of Nevada ore deposits into those formed at depth associated with granitic intrusive and those formed near the surface in connection with Tertiary volcanics has long been recognized. Evidence is accumulating suggesting that each of these groups should be again divided. The great Sierra batholith intruded at about the close of the Jurassic carries on its western flank satellitic batholiths with which are associated the quartz veins which have yielded the great California gold production. On the eastern flank the geologic conditions are similar but the veins accompanying the satellitic batholiths, though similar in appearance and mineralogy to those of California, have yielded no important gold production. Owing to favorable climatic conditions, however, these western Nevada veins have undergone secondary enrichment in silver, and it was from these rich secondary ores that the great silver production of such camps as Austin and Belmont was obtained. These were for the most part exhausted many years ago. Replacement and contact deposits are relatively rare. The Sierra region yields a very small percentage of the country's production of base metals, chiefly copper. A very different condition prevails in the interior region. Here intrusions of Eocene age have associated with them deposits, chiefly of the replacement type, valuable chiefly for base metals, and the vein type of deposit though present is not predominant.

The line of division between the two prevailing types seems to pass through the middle of Nevada. To the west the deposits are mostly of the vein type, rich in silver near the outcrop but disappointing in depth. In the eastern part of the State on the other hand the rich secondary silver ore at the outcrop in many places passed in depth to workable lead-silver ore. The inference is drawn that the Western Nevada veins deposits allied with the Sierra batholith were formed at about the close of the Jurassic, whereas those in the eastern part of the State, showing strong affinities with the Rocky Mountain type, should be tentatively placed in the Eocene. This is not in accord with Lindgren's suggestion that the locus of the Cordilleran intrusions moved gradually eastward but implies two distinct and widely separated periods of batholithic intrusion.

The proposed division of the near-surface deposits is based largely on work in the region of the Tonopah and Hawthorne degree sheets. Here certain deposits such as those of Tonopah and Aurora are associated with lavas of pre-Esmeralda age, that is, older than the upper Miocene. Manhattan, Round Mountain, Goldfield, Bodie, and a number of less important deposits are definitely post-Esmeralda in age. The deposits of the Tonopah-Aurora type are so widespread over Nevada that it is surmised that this was the major period of late Tertiary mineralization. The characteristic features are strong veins, the presence of primary argentite and commonly other silver minerals, free gold heavily alloyed with silver, usually about equal parts by weight, and often fairly abundant base metal sulphides. Although many of these are properly gold camps if value of output is considered, in all cases the weight of silver produced greatly exceeds that of the gold. This type is widespread; it is well represented in Mexico, New Zealand, and the East Indies and has been called the Pacific type of ore deposit. Of the relatively few deposits with predominant gold, Bodie, Goldfield, Manhattan, and Round Mountain are known to be of post-Esmeralda age, and it is inferred that further work may place the others there also. These deposits do not form as distinct a class as the pre-Esmeralda group. In most of the less important and also Round Mountain, Bullfrog, Oatman, and part of the Manhattan district, free gold is the only important metallic mineral, the amount of sulphides being very small and barren. In Goldfield, and part of the Manhattan district, however, complex mineral associations prevail. Commonly, the veins are less persistent and less well defined than those of the earlier type Primary bonanzas of great richness may occur, but the productive depth is on the average less than in the pre-Esmeralda silver deposits.

Although it will be many years before the succession of lavas throughout the Great Basin is well enough known to speak with any certainty, the available evidence points to a widespread mineralization prior to the Upper Miocene. This is allied in type and therefore possibly in age with deposits in all regions bordering the Pacific. The post-Miocene deposits are of different character and possibly only of local importance. It appears, therefore, that there have been four distinct periods of major mineralization in Nevada. The first is closely allied to the Sierra gold type, but unfortunately deficient in gold, of post-Jurassic age, and prevails in the western part. The second which might be called the Rocky Mountain type, prevails in the eastern part of the state, and is probably of Eocene age. Mineralization of probable Miocene age with predominant silver was widespread, while a later period probably early Pliocene, has yielded relatively few deposits of importance. (*Author's abstract.*)

W. G. ALDEN: *The Gros Ventre landslide of June, 1925.* On June 23, 1925, there occurred in the valley of Gros Ventre River, about 35 miles south of Yellowstone Park and near the east side of Jackson Hole, Wyo., a landslide which carried down from the adjacent slope and deposited in the valley many million cubic yards of rock debris. This slide, which occurred within a space of a few minutes, formed a dam about 225 feet high and half a mile long, which completely blocked the river and so impounded the water as to form a lake 4 or 5 miles long, with a maximum width of about three-quarters of a mile. This lake submerged much of three private ranches and one ranger station of the Teton National Forest, and has created a situation more or less perilous to ranches and villages all the way down the Gros Ventre and Snake River valleys. This appears to have had no connection with the Montana earthquake which occurred four days later. The Gros Ventre valley in this part is cut several thousand feet into upturned Cretaceous, Jurassic, and Triassic rocks. The slide occurred at the heavily wooded north end of the long north spur of Sheep Mountain, one of the northern peaks of the Gros Ventre Range. It was probably due to the saturation of clay shale interbedded with the Carboniferous limestones and sandstones as the result of heavy rains and melting snows. The strata at this place, on the south side, dip into the valley at angles of 18 to 21 degrees, and the movement was obliquely down the dip. The upper end of the slide is at the top of the slope about 1½ miles south of the river and 1700 to 2200 feet above it. The front of the great mass of rock debris and forest trees plunged across the half-mile-wide valley bottom and piled up 400 feet high against the red sandstone cliff on the north, then settled back somewhat. The flooded stream rapidly filled the basin thus formed and in about three weeks the water rose 220 feet back of the dam. It is estimated that about 150,000 acre feet of water was impounded over 2000 acres of land. As the inflow decreased, seepage began and increased to 400 or 500 second feet, so that the dam was not overtopped It was reported late in January, 1926, that no particular change in conditions had taken place up to that time. The great point of interest is as to what will occur next spring, inasmuch as it seems certain that the dam must be overtopped if there is any such spring flood as occurred in 1918 when the flow at Kelly, four miles below the site of the dam, reached a peak of 6000 second feet and averaged 4000 second feet for two weeks. (*Author's abstract*)

413TH MEETING

The 413th meeting was held at the Cosmos Club, February 10, 1926, Vice-president LEE presiding.

Program: R. T. EVANS: *Erosion forms in Zion National Park, Utah.* W. T. LEE: *Some scientific aspects of the Mammoth Cave region, Kentucky.*

414TH MEETING

The 414th meeting was held at the Cosmos Club, February 24, 1926, President DARTON presiding. The Secretary announced the election to active membership of PARKINSON POPINOE and Miss TAISIA STADNICHENKO. W. T. SCHALLER was awarded by ballot the prize of $10 for excellency in presentation of papers during the first third of 1926.

Program: H. W. HOOTS: *Geologic features of the southern end of the San Joaquin Valley, California.* The San Emigdio Mountains lie at the southern end of the San Joaquin Valley. They trend in an east-west direction and, together with the Tehachapi Mountains farther east, form that elevated area which connects the southern end of the Sierra Nevada range with the Coast Ranges. The geologic character of the San Emigdio Mountains, broadly considered, is intermediate between that of the Sierra Nevada range and that of the eastern Coast Ranges of this region in that it has a central mass of granodiorite which connects with the Sierra Nevada, and a northern foothill belt of highly disturbed Tertiary sediments which broadens progressively westward. The San Andreas fault lies south of the San Emigdio Mountains, trends S 80° E, and separates the granodiorite from a much folded and faulted mass of Tertiary strata. Approximately 24,000 feet of Tertiary and Quaternary sediments, ranging in age from Eocene to late Pleistocene, lies north of the granodiorite. These rocks, consisting of massive sandstone and conglomerate, soft shale, volcanics, and coarse fanglomerate are folded into pronounced anticlines and synclines with east-west trend and are broken by many faults. All major folds, without exception, have their north-dipping limbs the steeper with inclinations of 45°–60° in contrast to south-dipping limbs of 20°–30°. The major faults, one of which appears to be an overthrust of low angle south dip, also trend east-west, approximately parallel to the San Andreas fault farther south, and have stratigraphic displacements as great as 5,000 feet; minor faults, apparently with vertical planes, trend either northeastward or northwestward. It is considered likely that these structural features have resulted from northward thrusts from the south during late Tertiary and Quaternary time similar in effect to those which, during the earthquake of 1906, produced relatively northward movement of the fault-block west of the San Andreas rift. That movement of this western fault-block has actually been northward during the past 30–40 years is attested by recent resurveys of the Coast Ranges by the U S. Coast and Geodetic Survey. Wheeler Ridge, the topographic expression of one of the most prominent east-west trending asymmetrical anticlines, lies at the northern edge of the foothills directly in front of the major fault which appears to be of low-angle overthrust type. Study of its structural details and probable origin leads one to believe that it has been subjected to thrusts from the south since the anticline, developed in late Pliocene and Pleistocene strata, was formed. In conclusion, the stratigraphy, pronounced development of solifluction and large earth-flows, and the physiographic history of a part of the foothill region were briefly described. (*Author's abstract.*)

F. L. Hess: *The source and use of cesium.* Pollucite is the only known cesium-bearing mineral and it has been found only on the Island of Elba, where it was discovered and occurs as a mineralogical curiosity. At Buckfield, Maine, it has been found in comparatively large quantity and a few thousand pounds has been mined. The pegmatite which has been mined during the last summer by W. D. Nevel and previously by Perien S. Dudley, is an almost diagrammatic representation of the theory brought out by the writer[1] of the gradual growth of pegmatites from fine grained masses to those containing huge individual crystals or masses of single minerals. A dike of coarse granite about 15 feet wide cuts across the gneiss on Hodgeon Hill, 3½ miles southwest of Buckfield. Following a crack in the granite and lying close to one side is a mass of pegmatite, following a rather irregular course and varying in width from 3 or 4 feet to perhaps 10 feet. In places the pegmatite is composed of irregular masses of microcline, biotite, muscovite and quartz. Within these masses are bodies of rock which are composed of crystallized microcline, individual crystals of which may be 5 or 6 inches through. With the crystallized microcline, is, in places, clevelandite (platy albite) cassiterite, blue and green tourmalines, colorless pink and blue beryl of indistinct crystal form, and pollucite. The pollucite is usually without form, partly glassy and partly crushed to a powder. The pollucite is found only where the microcline is crystallized and with the higher temperature minerals just noted. It is usually surrounded by a coat of lepidolite about 1/32 inch thick, normal to the pollucite, and veinlets of pale lepidolite cut the pollucite. At places in the pegmatite radial veinlets not much thicker than a hair are filled with arsenopyrite and at the ends of the rays are crystals of black tourmaline. Cracks running into the dike show incipient pegmatitization. (*Author's abstract.*)

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[1] Hess, Frank L. *The natural history of pegmatites.* Engin. and Min. Journ. **120**: 289–298 1925.

C. P. Ross: *Some features of the Paleozoic stratigraphy of Idaho.* A large part of Idaho has now been geologically studied in reconnaissance fashion and detailed work has been done in a number of localities. Although much of the latter is still unpublished it was available in the preparation of the present paper. Only in the southwestern part of the State is it likely that facts of major stratigraphic importance await discovery, although a multitude of details are still unknown in almost all parts of the State In spite of the bewildering rapidity of change in the Paleozoic stratigraphy within short distances in many parts of the State, it has been possible to construct more or less tentative stratigraphic columns for nearly all parts of Idaho and to work out some of the broader features of the Paleozoic stratigraphy. During much of the Paleozoic a narrow sea extended north from its connection with the Pacific near Lat. 35 N, along the present position of the Rocky Mountain Cordillera, covered much of eastern Idaho, and had frequent connection with the Arctic Ocean. The Cambrian sea in Idaho extended north as far as the 45th parallel and west beyond the 115th meridian. A sea also covered part of northern Idaho in the Cambrian but probably had no connection within the State with that in the south. The other Paleozoic seas did not extend as far north or west as did the Cambrian, but deposited many thousands of feet of sediments in southeastern and southcentral Idaho. The only known Paleozoic beds in western Idaho are of Carboniferous age In the Permian, at least, the sea here had a connection with that in eastern Idaho. This connection may have been across the central part of the State, where volcanic strata of supposed Permian age have recently been found, but more probably was across southern Idaho or northern Nevada. The position of the shoreline probably shifted almost constantly during the Paleozoic but in general corresponded fairly closely with the eastern boundary of the so-called Idaho batholith, a fact which is probably of structural significance. (*Author's abstract.*)

Program: M. R. Campbell· *The meaning of cut-off meanders in tidal streams.* The presence of stream meanders and of cut-off meanders on the tidal streams of Virginia raises the question of the conditions under which such features will be developed and consequently their value in interpreting the geomorphic history of the region in which they occur. A study of the lower Mississippi, the San Jacinto River below Houston, Texas, and the James River from City Point to its mouth shows that as soon as a stream reaches tide water it loses most, if not all of the features and habits of a normal· stream and in this condition there is little or no tendency to form meanders or to cut them off. If this conclusion is correct, the presence of meanders or meander scars at any particular level indicates that at the time that level or terrace was formed the stream was above tide level and behaved as a normal stream behaves. The application of this principle should materially assist in deciphering the recent geomorphic history of the embayed section of the Atlantic Coastal Plain. (*Author's abstract.*)

WILLIAM BOWIE: *The importance of geophysical data in geologic research.*

415TH MEETING

The 415th meeting was held at the Cosmos Club, March 10, 1926, President DARTON presiding. The Secretary announced the transfer of the following members from the active list to the corresponding list: ARTHUR HOLLICK, ROBERT ANDERSON, H. F. BAIN, J. P. BUWALDA, ERNEST HOWE, T. C. HOPKINS, W. S. BURBANK.

F. E. MATTHES: *Some examples of the cellular structure of ice.* The speakers showed several lantern slides of photographs taken by him in Rock Creek Park, Washington, D. C., on Jan. 24, 1926, of cakes of ice in which the cell structure, as it is termed by some authors, had been rendered clearly discernible at the surface by a fortuitous train of circumstances. After the ice on the ponded stretches of Rock Creek had attained a thickness of about 5 inches, a change in weather brought about a flood, which broke up the ice and cast large cakes of it on the banks of the stream. There, exposed to the mild heat of the winter sun, the surfaces of the cakes became etched along the lines of contact between the cells, the interstitial films, or cell walls being more sensitive to radiant heat than the crystalline ice, as has recently been shown experimentally by E. K. Plyler. A brief snow flurry then supervened and the etched grooves were filled with fine powdery snow, the result being that each individual ice cell stood clearly outlined by a white boundary. The photographs revealed great variety in the horizontal dimensions of the cells. As a rule the cells measured only a quarter to half an inch across, but some of them measured an inch or more across. A few cakes contained cells measuring 3 to 7 inches to the side. The commonly accepted theory is that each cell envelops a single crystal, and this is probably true of the small and medium-sized cells, which largely preponderate; but it scarcely seems probable that the very large cells mentioned contain each but a single crystal. As a matter of fact, when the ice composed of these large cells was broken, there were revealed vertical flutings along the cell walls as well as a dim structure here and there within the cells themselves, suggesting the presence of a multitude of thin, almost fibrous, crystals closely intergrown. It may well be, therefore, that ice cells and ice crystals are not always coterminous, but that under certain conditions aggregates of crystals may be enveloped by one cell. The observation made, though lacking verification by microscopic analysis, may have a bearing on the probable composition of the interstitial films. There are in the main two views: (1) that these films consist of water holding salt or other mineral matter in solution and therefore having a low freezing point; (2) that they are made up of loose molecules of ice not definitely attached to the lattice work of the crystals. It seems entirely possible that both kinds of interstitial films are present in ice; the latter normally separating crystal from crystal, the former being present wherever there are appreciable quantities of dissolved mineral matter in the water, and being segregated as freezing goes on, in the form of so-called cell walls that may enclose one or more crystals of pure ice. (*Author's abstract.*)

416TH MEETING

The 416th meeting was held at the Cosmos Club, March 24, 1926, President **Darton** presiding. The Secretary announced the resignation of C. D. **Davis**, a founder and active member, and the transfer of the following members from the active list to the corresponding list: M. W. **Ball**, W. C. **Phalen**, C. M. **Keeler**.

Program: **Frank Reeves**: *The landslide origin of the thrust faults around the Bearpaw Mountains.* The thrust faulting in the plains on the north and south sides of the Bearpaw Mountains is apparently confined to the weak upper Cretaceous and early Tertiary formations. The trend and extent of the faults indicate that they were produced by a thrust force acting outward from the mountains. The slight plainsward inclination of the strata toward the faulted area suggests the possibility that during the mid-Tertiary period of volcanic activity in the mountains, these formations, being buried under an enormous load of extrusive material and subjected to violent and frequent earthquake shocks, slipped plainsward on wet bentonite beds in the upper part of the Colorado shale, resulting in the compression and thrust faulting of these formations in the plains. (*Author's abstract.*)

B. S. **Butler**: *Some features of the native copper deposits of Michigan.*

N. H. **Heck**: *Some unusual submarine features in the north Pacific Ocean.* The area referred to in the paper includes the rim of the North Pacific ocean from the Panama Canal to the Philippine Islands. A deep ocean trough developed by the Coast and Geodetic Survey Steamer GUIDE in 1923 is found to be associated with a large number of earthquake epicenters along its extent from Panama to the Gulf of Lower California. Another series of epicenters further off shore are in line with a series of oceanic islands and reefs. From Lower California to Alaska submarine activity appears limited. There are a number of cases of submarine earthquakes along the extension of the San Andreas fault off the coast of Northern California. Attention was called to the existence of a submarine crater off the coast of southeastern Alaska, and there was brief discussion of the pinnacle rocks found in the waters of southeastern Alaska. Special attention was called to the small base and consequent very steep slopes of the sides of these pinnacles. The Yakutat Bay earthquake of 1899 was accompanied by a vertical change reaching nearly 50 feet, the greatest heretofore recorded in a single earthquake on land during the historic period. Besboro Island in Bristol Bay north of the Aleutian Islands rises to a height of 1600 feet in a generally flat region. It is probably the remains of volcanic cone. Volcanic activity in this region resulted in the formation in a comparative recent period of Bogoslof Island north of the Aleutian chain. Paralleling the Aleutian chain to the south there is a great deep extending from the mainland of the Aleutian Islands to Kamchatka apparently without break, though the soundings are few. It was pointed out that the extension of the axis of this deep follows a submarine valley to the Alaska coast, reaching it at Yakutat Bay. Many earthquake epicenters are associated with this deep and there is evidence of considerable activity to the south of it. A series of deeps from Kamchatka along the Japanese Islands to the Philippines are well known to be the most active seismic region of the earth. A number of epicenters plotted within the outlines of the deep bring this out very clearly. It is here that the greatest known ocean depths are found. Another branch extends from Japan through the Marianna Islands, a very active region with earthquakes of both volcanic and tectonic character.

The need for complete surveys of the North Pacific in order to understand these features better was stressed. A case of sudden change in depth over a limited area greater than that recorded at the time of the Yakutat earthquake was described. In the Cuyo Islands in Zulu Sea, Philippine Islands, an area of about half a square mile dropped an average amount of 100 feet between two surveys eighteen months apart. An earthquake occurred during the period. This case has been published in detail in the Geographical Review for April, 1926, by Lieut. Com. F. H. Hardy of the Coast and Geodetic Survey. (*Author's abstract.*)

417TH MEETING

The 417th meeting was held at the Cosmos Club, April 14, 1926, President DARTON presiding. The Secretary announced the transfer of the following members from the active list to the corresponding list: J. M. HILL, C. K. WENTWORTH, O. B. HOPKINS, R. W. STONE, F. L. RANSOME, T. W. VAUGHAN, H. F. SACKETT.

Program: W. P. WOODRING. *Geologic history and paleobiologic significance of the genus Clementia.* *Clementia* is a clam-like bivalve mollusk that has a characteristic *Inoceramus*-like sculpture. A review of all the known fossils indicates that this genus first appeared in the eastern tropical Pacific or in the Caribbean region during middle Eocene time. It may represent an invading type in both these regions, for a divergent phylum appeared at virtually the same time in the Paris Basin. It is assumed that the genus migrated into the Orient by way of the north border of the Pacific during early or middle Tertiary time and that the isolated Miocene finds in the Mediterranean region represent a temporary invasion from the Orient. After Miocene time the main phylum completely disappeared in American and European waters and all the living species are found in the western Pacific and Indian Oceans. During Miocene time another divergent phylum, known as the subgenus *Egesta,* arose in American waters. It also migrated around the north border of the Pacific. After Miocene time this subgenus also disappeared in American Atlantic waters, but one species still lives in the Gulf of California. The only other living species is found in the waters off Japan and Chosen. *Clementia* is a mud-burrower and its shell, like that of other mud-burrowers, is very thin. Living species are found either in very shallow protected water or in deeper exposed water at a maximum depth of 85 fathoms. The fossils are found in mud beds almost invariably with both valves in attached position, showing that they died and were buried at the place where they lived. Fossil species of *Egesta* are found in both mud and sand beds and their shell generally is thicker than that of *Clementia.* *Egesta* tolerated a lower range of temperature than *Clementia.* All the fossil species from the United States and Mexico represent *Egesta,* whereas all the species from the Caribbean region and the Pacific coast of Central America and northern South America represent *Clementia.* (*Author's abstract.*)

CHARLES BUTTS: *The Devonian of Alabama and the unconformity at its base.* Omitting the Chattanooga shale, the age of which is in dispute, the Devonian system is not well represented in Alabama. There is a very small area of limestone of Helderberg, probably New Scotland, age in the northwestern corner of the State which extends into the State from the Tennessee Valley area in Tennessee on the north. The Jemison chert with *Meristella lata* of Oriskany age, and the Yellow Leaf quartz schist overlying the Jemison chert, crop out in a narrow belt in Chilton County in the vicinity of Jemison.

The Jemison is known only by its chert which resembles the chert of the older Copper Ridge dolomite and was mapped on the 1894 edition of the geologic map of Alabama as Knox dolomite. Both the Jemison chert and the Yellowleaf quartz schist are members of the Talladega slate as it has been delimited in Alabama. In a broad belt extending northwest to Georgia from the Coastal Plain between Tuscaloosa and Talladega counties, are beds of sandstone and shale of Devonian age. In Red Mountain southwest of Bessemer characteristic Oriskany fossils were obtained from a quartzite and chert 8 inches thick underlain by 5 feet of sandstone, which may also be Oriskany. Oriskany fossils were also obtained from chert 1 mile southwest of Vance, Tuscaloosa County. Northeastward in Cahaba and Coosa Valleys the Devonian is represented mainly by shale and sandstone from 2 to 50 feet thick overlying limestone of Beekmantown or Little Oak (Chazy) age or, in Shelby and Bibb counties, the Athens shale, also of Chazy age, which underlies the Little Oak limestone. The Devonian in this belt is entirely of Onondaga and Hamilton ages. It includes the sandstone of Frog Mountain in Cherokee County, which was named by Hayes the Frog Mountain sandstone and which was considered as of Oriskany age. The name Frog Mountain has been also applied to the beds of Devonian age throughout all of this belt, that is, all the Devonian in Alabama except the Helderberg in the northwest, the Jemison chert, and the Yellowleaf quartz schist has been designated Frog Mountain sandstone. Among the most notable exposures and fossil localities of the Devonian in this belt are those at Watkins Cut 1 mile east of Odenville and in an abandoned quarry 1½ miles south-southwest of Ragland, 25 miles northeast of Birmingham. At the Ragland locality the Devonian is fully exposed in the quarry face and is composed of a thin limestone below and of shale and sandstone with cherty nodules above, the whole being 54 feet thick. Here the lower 4 feet is profusely fossiliferous, the coral fauna being most conspicuous, and recalling the rich coral fauna of the "Falls of the Ohio" at Louisville, Ky The entire fauna contains both Onondaga and Hamilton forms, the latter predominating. The lower limestone of the Devonian, eight inches thick, is here cemented to the underlying Little Oak limestone along a very even contact, notwithstanding a hiatus due to the absence of several thousand feet of rocks, including all the Black River, Trenton, Utica and Loraine of the Ordovician, the Richmond, the entire Silurian, and the Lower Devonian. A full description of the Devonian is contained in the Geology of Alabama, pp. 141–158, 1926, published by the Geological Survey of Alabama. (*Author's abstract.*)

J. B. MERTIE, JR.: *Stratigraphy of the Upper Yukon Valley.*

418TH MEETING

The 418th meeting was held at the Cosmos Club, April 28, 1926, President DARTON presiding The Secretary announced the transfer of D. F. MACDONALD from the active list to the corresponding list:

Program: KIRK BRYAN: *Solution-facetted limestone pebbles.*

G. R. MANSFIELD: *Summary of the geology of southeastern Idaho with notes on recent work.* The strata of southeastern Idaho include about 46,000 feet of sedimentary rocks, which are grouped in 41 formations, embracing lower middle Cambrian to Quaternary rocks and representing every period within that interval. There are many varieties of igneous rocks, but only three principal types—hornblende andesite porphyry, rhyolite, and olivine basalt. Five to eight epochs of volcanic activity have been recognized. The structural features include many folds, some as long as 75 miles, the Bannock overthrust, the Blackfoot fault, which is a transverse thrust, and the Meadow Creek graben, besides other faults both normal and reverse. Thirteen physiographic stages have been identified and described. These features have been discussed in earlier brief papers and in a professional paper now in press. The more recent field studies have been in the Portneuf, Paradise Valley, and Ammon quadrangles, where additional folds and faults have been mapped. A window in the Bannock overthrust appears in the Portneuf quadrangle, and the Bannock overthrust itself is exposed in several branches in the two other quadrangles named. It passes beneath cover of Tertiary beds and lavas in the southern part of the Ammon quadrangle. (*Author's abstract.*)

B. C. RENICK: *Stratigraphy of the eastern part of the San Juan Basin, New Mexico.*

419TH MEETING

The 419th meeting was held at the Cosmos Club, May 12, 1926, President DARTON presiding. The Secretary announced the transfer of the following members from the active to the corresponding list· EUGENE STEBINGER, LLOYD GIBSON, THEODORE CHAPIN. W. P. WOODRING was awarded by ballot the prize of $10 for excellency in presentation of papers during the second third of 1926.

Program: W. T. SCHALLER: *What is a gem stone?*

C. E. RESSER: *The Cambrian in the Rocky Mountains.* Until a few years ago all work on the Cambrian belonged to the first or "accumulative" stage and but few attempts had been made to weld the gathered facts into a harmonious whole in accord with modern stratigraphic methods. More recently attempts have been made to assemble our information into some sort of order so that the data in hand may be more useful and future field work directed more intelligently. At present the Cambrian beds of Wisconsin, studied by Dr. E. O. Ulrich during the past 12 years, constitute the "standard" with which all other Upper Cambrian strata are being correlated. No "standard" sections exist for the Middle and Lower Cambrian and consequently efforts must be made to find suitable ones. It is estimated that not more than 30 per cent of the Cambrian fossils now in hand have been described. (*Author's abstract.*)

A. J. COLLIER: *The unconformity between the Madison limestone and Ellis formation in northern Montana:* An important unconformity occurs between the Madison (Mississippian) limestone and the Ellis (Jurassic) formation in northern Montana. Knowledge of this unconformity has been obtained from the many wells that have penetrated these formations on the Sweetgrass Arch north of Great Falls and from its exposure near Stocket twenty miles south of Great Falls, in the Sweetgrass Hills near the international boundary and in the Little Rocky and Bearpaw Mountains. The outcrop near Stocket shows a discordance in the dip of the two formations, the surface between them being irregular and occupied by a few feet of gravel sand and soil cemented by secondary silica and iron rust. This deposit comprises the basal "sand" of the Ellis or the "Ellis sand" of the drillers in the Kevin-Sunburst oil field. A few miles south of Stocket a small thickness of the Quadrant formation, (Mississippian or early Pennsylvanian in age) underlies the unconformity and near the Wyoming line Triassic rocks underly it. In the Sweetgrass hills and in the Bearpaw and Little Rocky Mountains the character of the unconformity is about the same as at Stocket though no discordance in the dip of the associated formations has been observed. In the front range of the Rockies west of the Sweetgrass Arch the unconformity is not exposed owing to the great overthrust fault which extends north and south in Glacier National Park. Near Banff west of this overthrust, however, there is a great thickness of limestone the upper members of which are thought to be younger than Madison and wells drilled about a hundred miles southeast of Banff in the Turner valley of Okotoks oil field have evidently penetrated this limestone below the Jurassic. In the Athabaska region 500 miles north of the Sweetgrass Arch the youngest Paleozoic rocks are Devonian and immediately above them occur the Athabaska tar sands believed to be of lower Cretaceous age. The unconformity here is probably a northern extension of the unconformity underlying Sweetgrass Arch and if so erosion progressed far enough to remove the whole of the Madison formation. This unconformity therefore represents a great peneplain eroded in late Triassic or early Jurassic time which extended about 800 miles north and south and 200 or more miles east and west. It was eroded on Triassic rocks at its south end; on Quadrant and Madison rocks in its middle part and on Madison and Devonian rocks at its north end.

The Ellis-Madison unconformity is of considerable economic importance in northern Montana for the deposits associated with it contain valuable pools of oil in the Kevin-Sunburst field. It may be of equal importance in Canada for the Athabaska tar sands and the oil in Turner Valley apparently are associated with it. (*Author's abstract.*)

420TH MEETING

The 420th meeting was held at the Cosmos Club, November 10, 1926, Vice-president BUTTS presiding. The Secretary announced with regret the death of Dr. W. T. LEE, an active member and First Vice-president for 1926.

Program: E. O. ULRICH and R. S. BASSLER: *Some experiences of European geology and the International Geological Congress.*

421ST MEETING

The 421st meeting was held at the Cosmos Club, November 24, 1926, Vice-president BUTTS presiding. The Secretary announced with regret the death of Dr. F. H. KNOWLTON, a founder and former President of the Society. The resignation of T. K. HARNSBERGER from active membership also was announced.

Program: W. T. SCHALLER: *Origin of polyhalite.*

LAURENCE LAFORGE: *New evidence on the Pleistocene swamps of Washington.*

422D MEETING

The 422d meeting was held at the Cosmos Club, December 8, 1926, Vice-president BUTTS presiding. The Secretary announced the election to active membership of R. C. MOORE, E. T. MCKNIGHT, and C. E. ERDMAN. Announcement was also made of the election to corresponding membership of Dr. H. S. LADD, of the University of Virginia, and of the resignation of R. W. PACK from active membership as of January 1, 1926. On recommendation of the Council it was announced that during the ensuing year the Proceedings of the Society would be offered at least once a month to the editors of the JOURNAL OF THE WASHINGTON ACADEMY OF SCIENCES for publication. Members were urged to present to the Secretary abstracts of papers at the time when they are given. Otherwise the papers will be published by title only, for the Secretaries will no longer consider it their duty to beg for abstracts.

Program: Professor **Charles P. Berkey**, of Columbia University, addressed the Society on *An outline of the geology of Mongolia.*

THIRTY-FOURTH ANNUAL MEETING

The thirty-fourth annual meeting was held at the Cosmos Club after the adjournment of the 422d meeting, President **Butts** presiding. The annual report of the secretaries was read and approved The Treasurer presented his annual report showing an excess of assets over liabilities of $1,276.89 on December 8, 1926. The auditing committee reported that the books of the Treasurer were correct.

The results of balloting for officers for the ensuing year were as follows: *President:* **Charles Butts.** *Vice-presidents:* **S. R. Capps, D. F. Hewett**; *Treasurer:* **J. B. Reeside, Jr**; *Secretaries:* **W. P. Woodring, W. W. Rubey**; *Members-at-large-of-the-Council:* **O. E. Meinzer, H. E. Merwin, C. S. Ross, James Gilluly, W. H. Bradley**; *Nominee as Vice-president of Washington Academy of Sciences representing the Geological Society:* **N. H. Darton.**

J. D. Sears, W. P. Woodring, *Secretaries.*

SCIENTIFIC NOTES AND NEWS

The Pick and Hammer Club met at the Geological Survey on January 8. The program consisted of reports on the Pan-Pacific Scientific Congress in Japan by **W. C. Mendenhall**; on the meetings of Section E of the American Association for the Advancement of Science, at Philadelphia, by **G. R. Mansfield**, and on the annual meeting of the Geological Society of America at Madison, by **R. S. Bassler, M R Campbell, W. T. Schaller**, and **Arthur Keith**. The Club met at the Geological Survey February 5 to hear a series of short contributions on *The stratigraphy and conditions of sedimentation of the Permian rocks of the Colorado Plateau.* **R. C. Moore, H. D Miser, C. R. Longwell, J. B. Reeside, Jr., James Gilluly, C. W. Gilmore**, and **David White** contributed to the program

Professor **Johannes Walther** of the University of Halle, Speyer Visiting Professor at Johns Hopkins University for the current year, on March 19 will talk to the Pick and Hammer Club on some of his observations on laterite and red sediments in the deserts of Western Australia. The talk will be illustrated with lantern slides

The Petrologists' Club met at the Geophysical Laboratory on January 18. **W. T. Schaller, C. S. Ross, N. L. Bowen, H. G. Ferguson**, and **M. I. Goldman** led a discussion on *The criteria of replacement.*

Dr. **William T. Thom, Jr.**, chief of the fuel section of the U. S. Geological Survey, has been appointed associate professor of geology at Princeton University, in effect at the fall term of 1927, and will give lecture and research courses on structural geology and petroleum and coal. He will continue geologic work for the Geological Survey during summer periods.

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GEOPHYSICS.- *The variation of latitude and the fluctuations in the motion of the moon.*[1] WALTER D. LAMBERT, U. S. Coast and Geodetic Survey.

E. W. Brown's[2] explanation of the apparently irregular fluctuations in the motion of the moon involves an expansion or contraction of the earth over irregular periods of years, decades or perhaps even centuries so as to change its principal moment of inertia with respect to the axis of rotation, the moment of angular momentum remaining constant. This involves a change in the going of our time-keeper, the earth, and hence a seeming change in the moon's place at any given time as shown by our clocks, not a real change in the motion of the moon itself. Brown's explanation does not require an expansion or contraction uniform along all radii but merely a contraction or expansion having an adequate *average* value. The surface of the earth is so diversified that it seems natural to assume an expansion different along different radii, at least in the outer portions. The principal axis would then shift its position, that is, products of inertia different from zero would be introduced.

Such a non-uniform expansion and contraction of the earth would be very convenient for explaining irregularities in the variation of latitude. I am considering variation of latitude only so far as it concerns shifting of the earth's axis of rotation, and shall treat *variation of latitude* and *motion of the pole* as practically synonymous. The annual portion of the polar motion has seemed to vary about as regularly as one might be led to expect from the variations in the annual phenomena—meteorological phenomena in the broad sense of the term to which the annual part of the variation is commonly and convincingly attributed. But the variations in the "free" period of 14 months are much more puzzling. Friction would inevitably damp out the free motion unless there were something to sustain or regenerate it. Although there is reason, to believe that the internal friction is small,[3] we can hardly suppose that the present free motion is the still undestroyed part of a motion that has gone on with decreasing amplitude since some early geologic era. Moreover, there have been frequent and puzzling changes in the amplitude and phase of the free motion.

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[1] Presented at a meeting of the American Astronomical Society, Philadelphia, December 29, 1926 Received February 2, 1927

[2] *The Evidence for Changes in the Rate of Rotation of the Earth and their Geophysical Consequences, with a Summary and Discussion of the Deviations of the Moon and Sun from their Gravitational Orbits* Transactions of the Astronomical Observatory of Yale University, 3: part 6

Earthquakes have been correlated with the variation of latitude, but the masses moved in known earthquakes appear on calculation to be inadequate to account for the observed peculiarities in the variation of latitude. On the other hand, the stresses due to the variation of latitude, assumed to exist, are very small, even when considered as mere "trigger" phenomena, that is, as stresses that do not of themselves cause earthquakes, but are merely the final increment of stress that pushes the accumulated and pre-existing stresses beyond the limits of crustal strength and so releases at some particular time an earthquake that would have occurred about that time anyway. Considered as a trigger phenomenon the variation of latitude gives stresses of precisely the same character as those due to the diurnal earth tides, but the stresses due to the average maximum diurnal earth tide, which occurs about once a fortnight, are about twelve times as large as those due to the largest usual maximum displacement of the pole. The trigger effect of the variation of latitude may therefore be disregarded. If, however, earthquakes and the irregularities in variation of latitude are both due to one common cause, the shrinking and swelling of the earth, the suspected correlation is easier to explain.

What seems to be needed is some deformation of the earth containing a spherical harmonic component of the second degree and first order, that is, a change in the products of inertia xz and yz, where the z-axis is the axis of rotation, a deformation by no means large, but from its very definition widely distributed.

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[3] See HAROLD JEFFREYS *The Earth, Its Origin, History and Physical Constitution*, Chapter XIV This contains a convenient summary of recent work, much of it done by Jeffreys himself.

What has been said with regard to the "free" motion applies also to the irregular motion, which seems to defy all analysis into periods, or at any rate a rational explanation of those periods into which the motion may have been forced by some Procrustean mathematical process. For instance, for some years prior to 1918, the mean north pole appears to have moved progressively towards North America, and then to have turned aside without apparent reason and moved in the general direction of Europe.[4]

All these phenomena find a natural explanation if only we can assume that the expansions and contractions of the earth suggested by Brown take place, but not with absolute uniformity in all parts of the earth. Indeed the diversity of the surface suggests diversity of behavior, especially as the expansions and contractions, in both Brown's opinion and mine, are probably confined to the outer portions of the earth. A departure from uniformity amounting to only a fraction of the average expansion or contraction necessary to explain the anomalies of the moon's motion would be of the right order of magnitude to explain the irregularities in the variation of latitude.[5]

Of course this expansion and contraction, uniform or otherwise, is for the present a *deus ex machina*, a makeshift hypothesis, the geophysical implications of which we cannot well consider in detail just now.

The interesting thing is of course to see whether the irregularities in the variation of latitude do in fact correspond to fluctuations in the lunar motions. The investigation is not easy, for trustworthy observations of the variation of latitude do not extend nearly so far back as do reliable observations of the moon. In both cases we are dealing with quantities small and none too well determined. Hence one is peculiarly liable to be led astray by a seductive theory and to attribute a deep significance to mere chance coincidences.

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[4] LAMBERT *An Investigation of the Latitude of Ukiah, Calif, and of the Motion of the Pole* U S Coast and Geodetic Survey Special Publication No 80 p 42 and 108

KIMURA *Provisional Results of the Work of the International Latitude Service—* September 6, 1922, March 6, 1924 Japanese Journal of Astronomy and Geophysics, 2: No 3 1924

[5] For effects of shifts of matter in displacing the pole see LARMOR and HILLS *The Irregular Movement of the Earth's Axis of Rotation*, etc Monthly Notices Royal Astronomical Society, 67: 22. 1906

LARMOR *On irregularities in the Earth's Rotation*, etc Monthly Notices Royal Astronomical Society, 75: 211 1915.

LAMBERT Op cit., pp 37–42

See also addendum to this paper

I profess no real familiarity with the difficult technical questions involved in a study of the lunar motions. Nevertheless, I have come to suspect, as a result of examining the records, that there may be a close connection between irregularities in the motion of the moon and irregularities in the variation of latitude. The corrections to the moon's tabular place, as determined by observation, seem to vary most rapidly, at just about those times when there is a sudden change in amplitude or phase of the free motion of the pole, or a marked progressive shifting of the mean pole.

In Brown's Fig. 1 (op. cit.) there is a sudden upturn about 1918 of the curve showing the correction to the moon's longitude, just about the time when the mean pole suddenly changed its direction of motion, as previously noted. There is a smaller irregularity in correction to the moon's longitude about 1907, about the time of a considerable increase in amplitude of the free motion of the pole, and about the time when the progressive displacement of the pole appears to have slowed down for a time.[6] Changes *per saltum* in the earth's moment of inertia would tend to give the curve of corrections to the moon's longitude sudden changes from one uniform slope to another slope likewise uniform and if accompanied by a change *per saltum* in the product of inertia would in general change the amplitude and phase of the free motion, and also the position of the mean pole but would not impart to it a progressive displacement.

This study has been more than a mere casual inspection but should not be dignified with the name of an exhaustive investigation. My chief purpose in putting the matter before you is to ask advice and suggestions from those who are familiar with either latitude problems or with lunar problems, or with both, so that it may be easier to detect real connections, if such exist, and to rule out apparent coincidences due to change and to prepossession in favor of a preconceived theory.[7]

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[6] LAMBERT (Op. cit.) p. 60 and figures 4a to 9b, pp. 21–28. This change is so small both for the moon and the pole that its reality is not beyond doubt.

[7] Since the above paper was presented discussion of the uniformity of the earth's rate of rotation at the meeting of the Royal Astronomical Society on November 12, 1926, as reported in *The Observatory* for December, 1926, has come to my attention. The participants in the discussion agreed that the evidence for irregularity of rotation is strong, but some attributed the changes to changes in the earth's angular velocity alone with the moment of inertia left unchanged. For the mathematical theory of this assumption see addendum to Larmor's article previously cited, Monthly Notices Royal Astronomical Society, 75: 218. 1915, and Glauert's article in same volume p. 492. The paper by H. S. JONES, which was read at this meeting, appears in the Monthly Notices, 87: 4. November, 1926.

ADDENDUM TO THE PRECEDING PAPER

(Jan. 28, 1927)

Suppose the surface of the earth to rise in some places and to sink in others. This change in the radius may be expressed by a series of spherical harmonic terms. It can readily be shown that most of the harmonic terms give zero effects in displacing the polar axis of figure. The only exceptions are the harmonic terms of degree two and order one; these may be represented by $h_1 \sin 2\phi \cos \lambda$ and $h_2 \sin 2\phi \sin \lambda$. ($\phi$ = latitude, λ = longitude). By a proper choice of the initial meridian these two terms may be reduced to one, $h \sin 2\phi \cos \lambda$. This is the only term in the expression for change of radius that needs to be considered in treating the displacement of the axis of figure. For slow displacements the pole of rotation tends to follow the axis of figure, and in this note no distinction is made between the two.

If this term represents a layer of matter of density σ added or removed up to a maximum height or depth of h, the corresponding displacement of the pole expressed in radians is

$$\Delta\phi = \frac{8\pi\sigma\, h\, a^4}{15\ (C-A)},$$

where a = radius of earth, and C and A are its principal moments of inertia about the polar axis and about an equatorial axis respectively. By introducing the values of C and A in terms of the earth's dimensions and density and of a we get for $\Delta\phi$ in seconds of arc

$$\Delta\phi = 7''.54 \times 10^7 \times \frac{\sigma}{\rho} \times \frac{h}{a},$$

where ρ is the mean density of the earth. Suppose now that change in radius is due not to addition and removal of a layer of matter, but by the swelling and shrinking up of matter down to a depth d below the surface. The change in elevation is thus compensated isostatically in the Pratt manner down to depth d. The corresponding displacement of the pole is much smaller, being in fact the expression above multiplied by $\frac{d}{a}$, that is

$$\Delta\phi = 7''54 \times 10^7 \times \frac{\sigma}{\rho} \times \frac{h}{a} \times \frac{d}{a}$$

As a numerical example take:

$\frac{\sigma}{\rho} = 0.6, h = 1$ meter and $\frac{d}{a} = \frac{1}{60}$, or $d = 106$ kilometers approximately;

we get

$$\Delta\phi = 0''.12.$$

This displacement is of the right order of magnitude to explain the irregularities in the variation of latitude, though in most cases several times larger than would be needed.

The average shrinking or swelling postulated by Brown to explain the motion of the moon varies from a few inches, when the expansion and contraction extends to the center of the earth, up to 12 feet when it goes down only to the depth of isostatic compensation, as in the example above.[8] In view of the diversity of the earth's surface there is no difficulty in imagining an irregularity of less than a meter in an average shrinking or swelling of twelve feet.

The difficulty with the hypothesis—other than the primal one of finding a cause for the shrinking and swelling—lies in the matter of sea level.[9] A uniform expansion or contraction would cause merely a very slight lowering or raising of sea level due to the increased or decreased area of the ocean basins, but an irregular expansion or contraction of an amount necessary to account for irregularities in the variation of latitude would cause oscillations of sea level that would be well within the limits of observation, that would in fact almost force themselves on one's attention.

A change in level due to the addition or removal of a layer of matter would be largely masked by the rise or fall in sea level due to the attraction of the layer and the change in level produced by the displacement of the pole, but this is not true of the change in radius produced by mere shrinking and swelling down to a moderate depth. Such changes in radius may be considered as isostatically compensated and as having therefore very little effect on sea level.

The suggestion[10] has been made that a not unreasonable change in the volume of the circumpolar ice sheets[11] might effect a change in

[8] Correspondence with Prof Brown develops the fact that he had in mind a different mode of expansion, namely, expansion in a thin layer just below the outer crust so as to push up the latter without altering its density For a given elevation or depression of the surface an expansion of the type intended by Brown would be twice as effective in altering the moments and products of inertia as the type here treated.

[9] Dr William Bowie called my attention to this

[10] This suggestion was communicated in a personal letter from Dr Harold Jeffreys of St John's College, Cambridge, who attributes it to Prof. J. W. Evans Jeffreys is to discuss it briefly in an early issue of The Observatory

[11] There are known to be gradual increases and decreases in these due to slight climatic fluctuations of obscure origin It would be very interesting to make a quantitative study if all the material were available.

the moment of inertia of the earth sufficient to cause the irregularities in its rotation that are reflected in the apparent errors in the lunar tables. The effect of an increase in the ice sheets would probably be to *decrease* the moment of inertia by lowering the level all over the ocean surface, which lies mostly in latitudes where the lowering would affect the moment of inertia more than in the high latitudes of the ice sheets.

On account of the lack of symmetry of the configuration of the continents and oceans a withdrawal of water from the ocean or an addition of water to it would produce an effect on the position of the earth's axis of figure. The quadratures made by Darwin and Turner[12] for a different purpose may be used for evaluating the effect. If enough circumpolar ice were melted to raise the ocean level one meter, the pole would be shifted by 0″. 22, which is several times as much as is needed to explain most of the irregular variation of latitude. The direction of displacement is such that the north pole would move southward along the meridian of 59° East of Greenwich. The moment of inertia with regard to the axis of rotation would be increased by about one part in ten million. This again is a quantity several times as large as the largest change needed by Brown to explain the irregularities of the moon. These figures are on the supposition that there is no yielding of the solid portion of the earth under the load of water. On account of elastic yielding they are subject to a slight diminution, especially those for the variation of latitude, which would be reduced to perhaps four-fifths of the amount given, the direction of the polar displacement being unchanged.

Prof. Evans' explanation of the lunar puzzle thus fits the latitude puzzle also in regard to the order of magnitude of the quantities involved. The amount of water required to be added or withdrawn, that is, say 10 to 30 centimeters, does not seem wildly unreasonable, though larger than can be readily granted. The explanation is probably therefore only a partial one.

The apparent tendency, previously noted for the irregularities in the motion of the moon and in the displacement of the pole to occur simultaneously is an indication at least that the phenomena are related and that the cause of the lunar irregularities is chiefly terrestrial. The alternate release and storage of water in the polar ice caps occurring in the slow oscillations of irregular climatic cycles may be an important element of both phenomena.

[12] On the *Correction to the Equilibrium Theory of Tides for the Continents.* Proceedings Royal Society of London, 40: 303 1886, or Darwin's Scientific Papers, 1: 328.

BOTANY.—*Two new grasses,* Psammochloa mongolica *from Mongolia and* Orthachne breviseta *from Chile.*[1] A. S. HITCHCOCK, Bureau of Plant Industry.

Recently a package of grasses was received from Dr. E. D. Merrill, comprising the grass part of the collections of Mr. R. W. Chaney on the Third Asiatic Expedition of the American Museum of Natural History. Several interesting species were found, one of which appears to be new and to constitute a new genus.

Psammochloa Hitchc., gen. nov.

Spikelets 1-flowered, the rachilla articulating above the glumes, not prolonged behind the palea; glumes about equal; lemma narrow, about as long as the glumes, membranaceous, villous, awned from between 2 minute blunt lobes, the awn deciduous; palea narrow, villous, as long as the lemma and not inclosed in it; anthers large, minutely pointed, bearing a few short stiff hairs.—A stout perennial rhizomatous grass with long narrow compound panicles. The genus differs from *Stipa* in the membranaceous lemma without a strong callus, in the weak deciduous awn and in the equal palea not inclosed The pilose-tipped anthers show a relationship to *Stipa* through the section *Lasiagrostis.* In aspect it resembles *Calamovilfa* but the callus is not bearded.

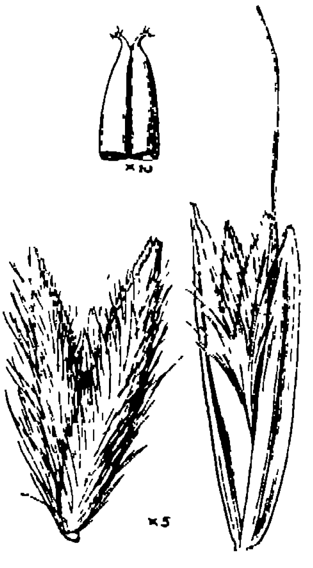

Fig. 1.—Spikelet and floret of *Psammochloa mongolica,* × 5 dia., anther tip × 10 dia.

Psammochloa mongolica Hitchc., sp. nov.

Culms 1 to 1.5 meters tall, erect, glabrous, from strong rhizomes; sheaths glabrous, ligule thin, about 1 cm. long; blades firm, glabrous, flat or soon involute, elongate, strongly nerved on the upper surface, 5 to 10 mm. wide, extending into a long fine involute point; panicle one-third to half the height of the plant, narrow, erect, pale and shining, the branches ascending or appressed, only slightly scabrous; spikelets about 1 cm. long, longer than the scaberulous pedicels; glumes equal, narrow, acute, weakly nerved, puberulent; lemma about as long as the glumes, narrow, villous, the awn weak, straight or somewhat flexuous, 8 to 10 mm. long, early deciduous, palea narrow, as long as the lemma, villous, not inclosed at maturity.

Type in the U. S. National Herbarium, no. 1,296,544, collected at Tsagan Nor, Outer Mongolia, on dunes at 1000 meters altitude, in 1925, by R. W. Chaney (no. 502) on the Third Asiatic Expedition of the American Museum of Natural History. A second specimen was collected at Gatun Bologai, on dunes, *Chaney* 443.

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[1] Received January 18, 1927.

In 1847 Hooker published a new species of *Muhlenbergia* (*M. rariflora* Hook. f.[2] from Cape Tres Montes, southern Chile, where it was collected by Darwin. Later this species was independently described by Steudel under a new genus, *Orthachne* (*O. retorta* Nees in Steud.)[3] and based on the same collection cited above. Miss D. K. Hughes (now Mrs. Wilson Popenoe) established the identity of the two species and took up the earlier specific name as *Orthachne rariflora* (Hook f.) Hughes.[4]

In a recent collection of Chile plants made by Dr. E. Werdermann, received from the Gray Herbarium of Harvard University, there was a new species which appears to be congeneric with the one mentioned above. *Orthachne* differs from *Stipa* in the membranous texture of the lemma which does not inclose the palea. As Miss Hughes points out[4] *Orthachne* differs from the allied *Streptachne* R. Br. of Australia in having the palea equal to the lemma instead of much smaller and in having a joint at the base of the awn. The new species described below has the faintly 1-nerved ovate-lanceolate glumes, the equal palea, and the habit of *Orthachne* (the glumes are narrow and the first is 3-nerved in *Streptachne*), but the awn is continuous with the lemma (not jointed). It differs from both *Streptachne* and the original species of *Orthachne* in the pilose midnerve and margins of the lemma. It seems to be more closely allied to *Orthachne* than to the Australian *Streptachne*, hence is included in the former. *Orthachne breviseta* differs from *O. rariflora* in the short curved awn (instead of 2 to 3 cm. long and very flexuous), the continuous (not jointed) awn, and the pilose lemma.

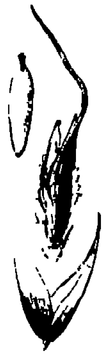

Fig 2.—Glumes, floret, and grain of *Orthachne breviseta*, × 5 dia.

Certain one-awned species of *Aristida* have been erroneously referred to *Orthachne* and *Streptachne*.

Orthachne breviseta Hitchc., sp. nov.

Perennial in dense tufts, culms erect or ascending, slender, glabrous, 15 to 30 cm. tall, having a single node near the base, leaves in a dense basal cluster; sheaths glabrous; ligules firm, obtuse, 1 to 2 mm. long; blades closely involute, glabrous, 0.3 to 0.4 mm. in diameter, sharp-pointed, somewhat curved or flexuous, 3 to 5 cm. long, the single culm blade below the middle, 1 to 1.5 cm.

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[2] Bot. Antarct Voy. 371. *pl. 131*. 1847.

[3] Syn. Pl. Glum. 1: 121. 1854

[4] Kew Bull Misc. Inf. 1923: 301. 1923.

long, panicles rather loose, 3 to 5 cm. long, somewhat nodding, the branches slender, glabrous, ascending, rather lax, 1 or 2 at a place, the lower as much as 2 cm. long; spikelets few, longer or shorter than the ultimate pedicels; glumes nearly equal, ovate-lanceolate, acute, 3 to 4 mm. long, glabrous, nerveless, the lower half purple, the upper half hyaline; lemma nearly terete, purple, about 4 mm. long, five-nerved, the intermediate pair of nerves very obscure, hairy between the lateral nerves and the margin, the midnerve densely short-pilose on the lower three-fourths, the callus short, acutish, densely short-pilose, the apex of the lemma gradually narrowed into a stout, scaberulous, curved, untwisted awn, 3 to 4 mm long, the sides of the lemma extending upward as two short slender teeth at the base of the awn; palea acute, as long as the lemma and not inclosed in it, pilose between the 2 faint adjacent nerves.

Type in the Gray Herbarium of Harvard University, collected on Volcàn Yates, Province of Llanquihue, Chile, alt. 1300 meters, March, 1925, by E. Werdermann (no. 669). The type is the only specimen seen.

BOTANY.—*New grasses from Panama.*[1] AGNES CHASE, Bureau of Plant Industry.

In preparing manuscript on the grasses for the forthcoming Flora of the Panama Canal Zone, it is necessary to use names of new species that have been in manuscript for some time awaiting the completion of revisions of genera. The proposed Flora will not contain descriptions, for which reason the new species from the Canal Zone and immediate vicinity are described here. Two new combinations are also made.

Thrasya Hitchcockii Chase, sp. nov.

A tufted perennial, culms rather slender, about 70 cm. tall, ascending, simple except for axillary leafless long-peduncled racemes, very flat, sparsely pilose, nodes constricted, the lower short-pubescent, sheaths keeled, pilose, especially at the summit and along the margin, or the uppermost nearly glabrous, ligule firm-membranaceous, about 1 mm. long; blades 15 to 30 cm. long, 5 to 6 mm. wide in the middle (the uppermost reduced or obsolete) tapering to both ends, rather firm, finely pubescent on both surfaces and coarsely pilose, at least at the base and along the margins, as well, the pale midnerve prominent beneath, inflorescence terminal and axillary, the solitary arcuate racemes 10 to 20 cm. long, on long very slender angled pilose peduncles, 2 or 3 peduncles from the uppermost sheath; rachis 2 mm. wide, the narrow membranaceous margins upturned, glabrous, or with a very few long hairs on the edge; spikelets subsessile, spreading about 45°, somewhat crowded, oblong-elliptic, turgid, 3.5 mm. long, 1.8 mm. wide; first glume minute or obsolete; second glume slightly shorter than the sterile lemma, faintly 5-nerved, pilose on the upper third and along the margins; sterile lemma subacute, deeply sulcate, slightly indurate, but thinner down the center and prob-

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[1] Received January 25, 1927.

ably splitting at maturity, faintly 5-nerved, the first lateral pair of nerves minutely crested at the apex, pilose along the margin near the summit, the sterile palea as long as its lemma, thin with firm nerves, subtending a rudimentary staminate flower; fruit elliptic, subacute, 3 mm. long, 1.5 mm. wide, the lemma and palea indurate, papillose-roughened, the lemma with a few stiff erect hairs at the apex.

Type in the U. S. National Herbarium no. 1,269,446, collected at the edge of a copse, on a hill, Chorrera, Province of Panama, September 16, 1911, by A. S. Hitchcock (no. 8140).

This species is intermediate between the two groups of *Thrasya*, the extremely specialized *T. petrosa* (Trin.) Chase and its allies and *T. cultrata* (Trin.) Chase and *T. campylostachya* (Hack.) Chase, which resemble *Paspalum pilosum* Lam.

Axonopus centralis Chase, sp. nov.

Perennial in large bunches; culms erect to stiffly spreading, simple except for the axillary inflorescence, 40 to 90 cm. tall, leafy throughout, compressed, glabrous, nodes glabrous, sheaths keeled, striate, hyaline-margined, usually pubescent on the overlapping edge, at least toward the summit, appressed-pubescent on the sides of the collar, ligule minute, firm, fimbriate; blades folded and keeled at base, flat above, rather lax, 15 to 50 cm. long, 8 to 10 mm. wide, rather strongly nerved, very sparsely pubescent on the upper surface, glabrous beneath, ciliate on the margin toward the base, inflorescence terminal and axillary, finally long-exserted on very slender striate peduncles, the terminal of 3 to 6 racemes, the axillary of 2 or 3, the upper 2 or 3 approximate, the lower remote, the common axis 1 to 6 cm. long, racemes 8 to 15 cm. long, lax, ascending or spreading, the slender rachis glabrous, minutely scaberulous on the angles; spikelets subsessile, mostly rather distant, oblong, 3 mm. long, 0.7 mm. wide, the glume and sterile lemma equal, extending one-third their length beyond the fruit, 3 nerved (rarely a faint outer pair in addition) or the midnerve commonly suppressed in the sterile lemma or in both, the lateral nerves of the glume extending into minute scabrous teeth at the apex, the internerves bearing a band of silky pubescence, fruit 2 mm. long, 0.7 mm. wide, oblong-elliptic, pale-stramineous.

This species is related to *Axonopus leptostachys* (Humb. & Bonpl.) Hitchc., from which it differs in its smaller size, fewer and much shorter racemes, and in the minutely dentate apex of the spikelet. This character has not been observed in any other species of the genus.

Type in the U. S. National Herbarium, no. 928831, collected in open grassland between Culebra and Pedro Miguel, Canal Zone, August 28, 1911, by A. S. Hitchcock (no. 7928).

Other specimens of this species are: PANAMA. Between Culebra and Pedro Miguel, *Hitchcock* 7928. Ancon, *Hitchcock* 19891. Taboga Island, *Hitchcock* 8077. NICARAGUA: Jinotepe, *Hitchcock* 8716.

Axonopus ater Chase, sp. nov.

A densely tufted perennial; culms ascending, simple except for the axillary inflorescence, 40 to 50 cm. tall, leafy at the base, compressed, glabrous, nodes appressed-pubescent; sheaths much shorter than the internodes, keeled, the margins stiffly ciliate; ligule minute, fimbriate; blades folded throughout, keeled, rather stiff, 4 to 15 cm. long, 4 to 5 mm. wide (opened out), obtuse and scabrous at the apex, sparsely papillose-ciliate on the margin; inflorescence dark purplish brown throughout, terminal and axillary, long-exserted on very slender peduncles, the terminal of 2 to 5, the axillary of 2 racemes, 2 or 3 digitate, the others 5 to 12 mm. below, racemes 4 to 6 cm. long, widely spreading, the center angle of the slender rachis sharply raised; spikelets subsessile, not crowded, oblong-elliptic, 1.7 to 1.8 mm. long, 0.7 mm. wide, the glume and sterile lemma equal, covering the fruit but not exceeding it, strongly 2-nerved, the midnerves suppressed, blotched with blackish purple, glabrous or the glume very obscurely pubescent at base, fruit about the size and shape of the spikelet, pale stramineous, minutely papillose-striate, the lemma with a very minute tuft of hairs at the apex.

Type in the U S. National Herbarium, no. 1,259,877 collected on moist clay on side of cut along railroad, Gatun, Canal Zone, September 2, 1911 by A. S Hitchcock (no 7976).

This species belongs in the group that includes **Axonopus Purpusii** (Mez) Chase (*Paspalum Purpusii* Mez[1]) differing from the North American forms in the smaller, glabrous blackish spikelets, and from the few South American species of this group having glabrous spikelets in the smaller blackish spikelets with two-nerved glume and sterile lemma

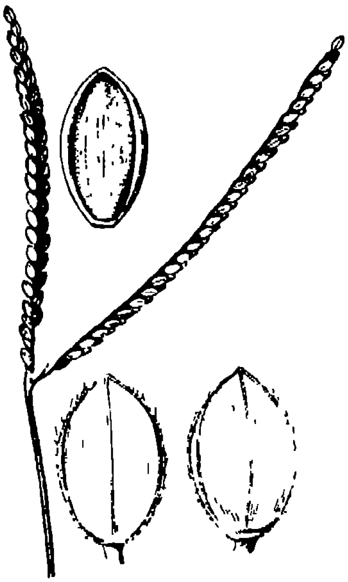

Fig 1 —*Paspalum subciliatum*, inflorescence, natural size; spikelet and fruit, × 10

Paspalum subciliatum Chase, sp. nov.

A tufted perennial; culms erect and crowded from a short horizontal rhizome, the innovations short and subglobose, resembling bulblets at the base of flowering culms; culms simple, 15 to 45 cm. tall, slender, compressed, striate, glabrous, leafy below; sheaths striate, glabrous or with a few hairs on the margins at the summit, the lower mostly short and crowded, the upper one elongate and bladeless, ligule ciliate, about 0.5 mm. long; blades erect, folded at base and slightly wider than the sheath, flat above, drying more or less involute, with attenuate tip, 10 to 20 cm long, 2 to 3 mm. wide (or occasional lower ones 5 to 8 cm. long and 5 mm. wide), long-pilose on the upper surface toward the base, otherwise glabrous, inflorescence long-exserted, with a dense tuft of short white hairs at base, racemes 2, conjugate (rarely a third below), narrowly ascending to spreading, 3 to 6 5 cm long, one usually a little longer and naked at the very base, rachis slender, flexuous, glabrous, purplish; spikelets grayish green, solitary, subsessile, scarcely or not at all imbricate, elliptic, subacute 2.2 to 2 4 mm. long, 1.2 to 1.5 mm. wide; glume and sterile lemma equal, covering the fruit, 3-nerved, the glume minutely pubescent, the hairs longer around the margin, the sterile lemma ciliate toward the summit, otherwise glabrous; fruit pale, very minutely papillose striate.

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[1] Bot. Jahrb Engler 56: Beibl 125: 10 1921

Type in the U. S. National Herbarium, no. 734821, collected in a savanna, in the vicinity of Balboa, Canal Zone, September 6, 1911, by A. S. Hitchcock (no. 8017). *Pittier* 4500, collected in Sabana de Juan Corso, near Chepo, Province of Panama, also belongs to this species.

This species belongs to the Notata group, and somewhat resembles *P. minus* Fourn., from which it differs in the more slender culms, subglobose innovations, narrower blades and especially in the grayish spikelets, pubescent on the glume with a delicate fringe of hairs showing from the flat (sterile-lemma) side.

Paspalum centrale Chase, sp nov.

Plants perennial, in small to rather dense and spreading tufts; culms often branching from the lower nodes, sometimes from the middle ones, ascending to spreading, occasionally geniculate and rooting at the lower nodes, 15 to 60 cm. tall (usually 30 to 45 cm), compressed, ridged, glabrous; nodes glabrous; sheaths rather loose, mostly exceeding the internodes, from sparsely to conspicuously pilose, sometimes glabrous except near the margins, rarely throughout, ligule brown, membranaceous, 2 to 3 mm. long, blades flat, ascending, 5 to 25 cm. long, 3 to 10 mm. wide (commonly 10 to 20 cm. long and 5 to 7 mm. wide, the uppermost reduced), long-acuminate, about as wide at the base as the summit of the sheath, pilose throughout, often sparsely so or rarely subglabrous on the under surface, racemes 2 to 6, distant about $\frac{1}{4}$ to $\frac{3}{4}$ their length, or the upper closer, 2 to 7 cm. long, mostly widely spreading, often arcuate, the common axis slender, narrowly winged, rather stiff, sometimes bearing scattered long hairs toward the summits of the internodes, the rachises 1 to 1 3 mm. wide, long-pilose at the base, the hairs sometimes as much as 10 mm. long, hispidulous and sometimes with a few scattered long hairs on the margins and on the midnerve above, spikelets mostly solitary (the secondary one of the pair rudimentary, or a few developed in some racemes) slightly or scarcely imbricate, 2 to 2.3 mm. long, 1 7 to 1 8 mm wide, elliptic obovate, olivaceous to brownish, glabrous, glume and sterile lemma barely or scarcely covering the fruit, rather fragile, 5-nerved, the outer one of the lateral pair sometimes obscure; fertile lemma and palea shining, very minutely papillose-striate, at first pale turning dark brown

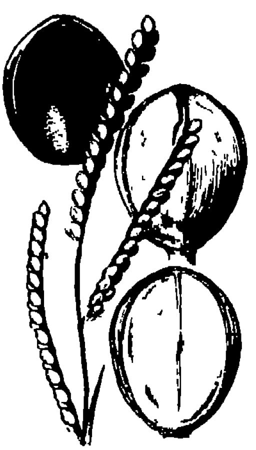

Fig 2 —*Paspalum centrale*, inflorescence, natural size; spikelet and fruit, × 10

Type in the U. S. National Herbarium, no 950876, collected in open flat meadow near the coast, La Union, El Salvador, November 13, 1911, by A. S. Hitchcock (no. 8789).

Along ditches and in moist open ground near the coast Salvador to Panama. The following specimens are from the Canal Zone: PANAMA: Culebra, *Hitchcock* 7985, 8059. Balboa, *Hitchcock* 8004, 8005, 8008, Chivi Chivi, *Killip* 4077. Las Sabanas, *Pittier* 6817.

This species is closely related to *Paspalum Boscianum* Flügge from which it differs in being perennial, not so coarse and less branching in habit, in the pilose foliage, in the relatively slender racemes, with narrower rachises and mostly solitary, rather less turgid spikelets. The panicles of depauperate plants of *Paspalum Boscianum* with solitary spikelets resemble shorter-racemed panicles of *P. centrale*, but such plants are readily distinguished by the difference in foliage. The spikelets of *P. centrale* never assume the rust-brown color characteristically (but not constantly) found in those of *P. Boscianum.*

Paspalum Standleyi Chase, sp. nov.

A slender tufted perennial, forming leafy mats, the culms spreading, some of them rooting at the lower nodes or creeping: culms 20 to 27 cm. long, slender, compressed, simple or branching at the base, glabrous or sparsely pilose below the nodes, nodes bearded with ascending hairs, the upper sparsely so: leaves aggregate at base, the sheaths keeled, the lower rather broad, papillose-pilose, especially along the midnerve and margin and on the collar, the upper glabrous except on the margin and collar; ligule minute, blades flat, spreading, 3 to 6 cm. long, 3 to 6 mm. wide, rounded at base, sparsely papillose-pilose on the lower surface, papillose (or with a few hairs) to glabrous on the upper, the upper blades mostly suppressed; racemes 3 or 4, spreading, 2.2 to 4 cm. long, on a slender glabrous common axis 1 to 1.5 cm. long, the axils glabrous or nearly so, the slender rachis dark purplish, glabrous, spikelets solitary on short flat pedicels, scarcely imbricate, narrowly ovate, somewhat unsymmetrical, subacute, depressed-plano-convex, 1.6 mm. long, 0.9 mm. wide, glabrous, pale or purple-tinged; glume and sterile lemma equal, barely exceeding the fruit, the midnerve suppressed, the marginal nerves strong, the sterile lemma obscurely longitudinally wrinkled in the middle, fruit 1.5 mm. long, 0.7 mm. wide, pale.

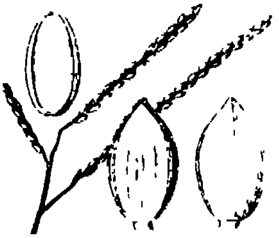

Fig 3 —*Paspalum Standleyi*, inflorescence, natural size; spikelet and fruit, × 10

Type in the U S. National Herbarium, no. 1,269,445, collected in marshy thicket, Juan Diáz, Province of Panama, January 11, 1924, by Paul C. Standley, no. 30543.

This species is allied to *Paspalum hyalinum* Nees of Brazil, from which it differs in its spreading habit, softer foliage, the blades much shorter and broader, and slightly larger spikelets, the thin glume and sterile lemma not hyaline and tearing in the middle as in *P. hyalinum*.

Paspalum acutum Chase, sp. nov.

A robust perennial, probably 2 meters or more tall; culms simple, glabrous, leafy to the summit; sheaths overlapping, compressed, striate, pilose on the margin at the summit, otherwise glabrous, the junction with the blade slightly constricted, dark colored, ligule membranaceous, 1.5 to 2 mm. long; blades about as wide as the sheath, slightly rounded and folded at base, flat above, 30 to 75 cm. long, 14 to 18 mm. wide, long-acuminate, glabrous beneath, sparsely pubescent on the upper surface and with long hairs back of the ligule, the margins sharply serrulate, the uppermost blade greatly reduced; inflorescence scarcely exserted (in specimens seen), the main axis rather slender, 10 to 15 cm. long, plano-convex, scabrous on the margins; racemes 6 to 10, thick, heavy, nodding, 9 to 12 cm. long, with a tuft of long hair at the base, the rachis 1 to 1.5 mm. wide, slightly flexuous, scabrous-serrulate on the margin, otherwise glabrous; spikelets in pairs on minute slender pedicels, imbricate, olive-green, elliptic, 3.5 to 3.9 mm. long, 2 mm. wide, abruptly acute; glume and sterile lemma equal, abruptly pointed beyond the fruit, 5-nerved, the lateral nerves close together near the margins, the glume silky-ciliate on the margin near the summit or nearly glabrous (spikelets varying in a single raceme), the lemma glabrous, fruit elliptic, 3 mm. long, 1.8 mm. wide, pale-stramineous, the lemma and palea minutely papillose-striate under a lens.

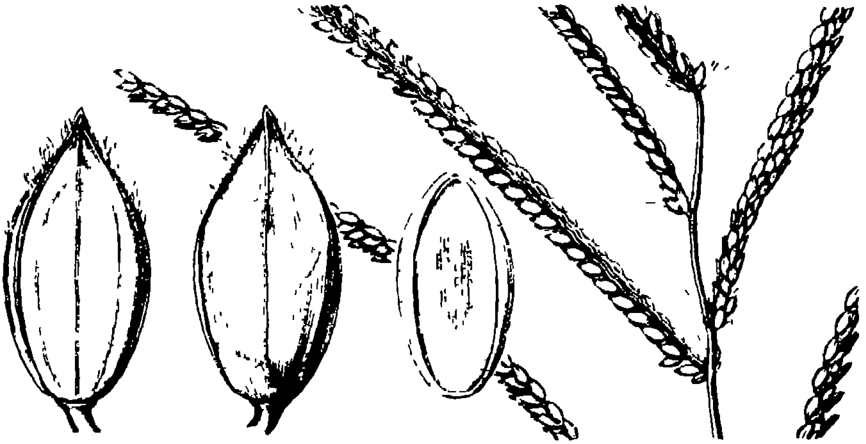

Fig. 4.—*Paspalum acutum*, inflorescence, natural size; spikelet and fruit, × 10

Type in the U. S. National Herbarium no. 1,037,443, collected in dry fields, Ancon, Canal Zone, September 18, 1917, by E. P. Killip (no. 4003).

The two specimens seen lack the base, but the species belongs to the Virgata group and is undoubtedly perennial. It differs from *Paspalum virgatum* L. in the more leafy culms and in the pointed elliptic spikelets, glabrous except the margin of the glume toward the summit, and in the pale fruit.

Sorghum vulgare sudanense (Piper) Hitchcock.

Andropogon sorghum sudanensis Piper, Proc. Biol. Soc. Washington **28**: 33. 1915.

Holcus sorghum sudanensis Hitchc. Proc. Biol. Soc. Washington **29**: 128. 1916.

PLANT ECOLOGY.—*The soil-reaction preferences of certain plant orders.*[1] EDGAR T. WHERRY, Bureau of Chemistry.

The data thus far published on the soil-reaction preferences of plants have referred chiefly to individual species or to ecological associations. It seems of interest to consider the matter from a different standpoint, namely, that of the orders into which plants naturally fall. The present study has been undertaken to ascertain whether any significant differences could be recognized in the soil-reaction preferences of the orders of higher plants represented in the northeastern United States.

The plan adopted was as follows. In a copy of the Check List of the Plants of Gray's Manual, 7th edition, 1908, the names of the orders, taken from that manual itself, were first inserted in their proper places between the families. Columns representing the several degrees of acidity or alkalinity to be recognized were then ruled in the margins, and a mark was placed opposite each species upon which any observations had been made, in the column corresponding to what appeared to be the optimum reaction-value for that species. The data were, finally, summarized and are presented herewith.

In a treatment so general as is here attempted, it is impracticable to recognize a large number of different degrees of acidity or alkalinity, and the number has been reduced to three, mediacid, subacid, and circumneutral. Although these terms have been repeatedly defined by the writer,[2] it seems desirable to state here their equivalence in terms frequently used by others. *Mediacid* signifies the highest degree of acidity commonly met in normal soils; in the "specific acidity" plan of statement it signifies an active acidity in the hundreds; in the logarithmic plan, it represents pH 4.1 to 5.0. *Subacid* represents, correspondingly, an active acidity in tens, or pH 5.1 to 6.0. Active acidity 10 or pH 6.0 appears to be the lowest degree of acidity at which oxylophytes or acid-place plants thrive. The plants which favor values of acidity lower than this seem, for the most part, to grow about equally well a similar distance on the alkaline side of the neutral point. The term *circumneutral*, which is accordingly applied to them, covers the range from an active acidity of 8 to an active alkalinity of 8, or from pH 6.1 to 7.9, inclusive.

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[1] Received January 24.

[2] *Soil acidity, etc.* Ecology, 1: 160. 1920; Smithsonian Annual Report, 1920: 247. 1922. *Soil reaction in relation to horticulture*, Bull. Amer. Hort. Soc. 4: 1. 1926.

In Table 1 a dash (–) is placed in a column opposite the order name when no significant number of species belonging in that order appear to thrive best at the reaction indicated, a lower-case x when a moderate number of species do so, and a capital X when the majority of the species show that reaction-preference. The summary indicates that very few orders prefer mediacid soils, and that approximately two-thirds of those covered fall in the circumneutral group. It is hoped that these data may be of use in considering the geological history of the plant orders, the reasons for their present distribution, and similar problems. Perhaps some day discussions of "reaction and range" may take the place of the current one on "age and area." The present preliminary note may serve to indicate to what extent differences between the soil-reaction preferences of plant orders may be looked for.

TABLE 1.—THE ORDERS OF HIGHER PLANTS IN THE NORTHEASTERN UNITED STATES AND THEIR APPARENT SOIL-REACTION PREFERENCES

PLANT ORDER	MEDIACID	SUBACID	CIRCUMNEUTRAL	PLANT ORDER	MEDIACID	SUBACID	CIRCUMNEUTRAL
Filicales	–	x	X	Ranales	–	x	X
Equisetales	–	x	X	Papaverales	–	x	X
Lycopodiales	X	x	x	Sarraceniales	X	x	–
Coniferales	x	X	x	Rosales	x	x	X
Pandanales	–	x	X	Geraniales	x	X	x
Najadales	–	x	X	Sapindales	x	X	x
Graminales	x	x	X	Rhamnales	–	x	X
Arales	x	x	X	Malvales	–	x	X
Xyridales	x	x	X	Violales	x	X	x
Liliales	x	x	X	Opuntiales	x	x	X
Scitaminales	–	–	X	Myrtales	x	X	x
Orchidales	x	X	x	Umbellales	x	x	X
Piperales	–	–	X	Ericales	X	x	x
Salicales	–	x	X	Primulales	–	x	X
Myricales	x	X	x	Ebenales	x	X	x
Juglandales	–	X	x	Gentianales	x	x	X
Leitneriales	–	–	X	Polemoniales	x	x	X
Fagales	x	X	x	Plantaginales	–	x	X
Urticales	–	x	X	Rubiales	x	x	X
Santalales	x	X	x	Campanulales	x	x	X
Aristolochiales	x	x	X				
Polygonales	x	x	X	Number with each optimum	3	11	30
Chenopodiales	–	x	X				
Caryophyllales	x	x	X				

ENTOMOLOGY.—*Some scoliid wasps from tropical America.*[1]

S. A. Rohwer, Bureau of Entomology, United States Department of Agriculture.

Recently I have received from Mr. Harold E. Box certain specimens of scoliids for identification. Among these was one species which was being introduced into Porto Rico to help in the control of white grubs. This species is new, and its description, along with some related forms and a species of *Elis*, is presented at this time to make the names available to authors who may be dealing with the economy and habits of these species.

Genus Campsomeris Guérin

GROUP TRICINCTAE

Some of the species here grouped around *tricincta* (Fabricius) were assigned by Saussure and Sichel[2] to their species group *plumipedis*. The other previously described species was characterized subsequent to Saussure's and Sichel's work. The species of the group *tricinctae* can be distinguished from *plumipes* and allies by the presence of dense red or reddish hair on the apical segments of the abdomen and the presence of a patch of hair on the wing membrane adjacent to the stigma. The following characters are common to all females of the group *tricinctae:*

Length 12–20 mm. Black; basal three or four tergites marked with yellow, head and thorax clothed with fulvous hair, thorax in some species marked with yellow; terminal abdominal segments clothed with fulvous or rufous hairs; wings infumate or subhyaline, costa usually darker and usually a dusky spot at end of radial cell (indistinct in *limosa*), area adjacent to stigma densely clothed with hair (less so in *limosa*).

Males of only two (*tricincta* and *fulvohirta*) of the species are in the National Collection. They may be assigned to this group by the dense red hair at the end of the abdomen.

Key to the females of group tricinctae

1. Posterior aspect of propodeum sloping, not sharply separated from the dorsal aspect which is closely covered with distinct, large punctures; sternites all black . . . . .2.
   Posterior aspect of propodeum perpendicular, sharply separated from dorsal aspect which is without *close* uniform punctures; sternites marked with yellow; area inclosed by first cubital and at least most of radial cells clothed with long hair; a dark spot beyond apex of radial cell . 3.
2. Dorsal part of posterior aspect of propodeum closely and coarsely sculptured; yellow markings on tergites interrupted into spots; only anterior part of area inclosed by first cubital cell clothed with hair, no distinct dark spot beyond radial cell. . . . .**limosa** (Burmeister).

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[1] Received January 28, 1927.

[2] Cat. Species Gen. Scolia, 243. 1864.

Dorsal part of posterior aspect of propodeum smooth, almost without punctures; first three tergites with yellow bands; area inclosed by first cubital and radial cells clothed with brown hair; wing beyond radial cell dark brown.................... **completa**, new species.

3. Disk of propodeum separated from the posterior aspect by a transverse ridge which is higher medianly; legs rufous; yellow markings of tergites forming continuous bands; pronotum without yellow spots **tricincta** (Fabricius).

No transverse ridge separating disk of propodeum from the posterior aspect; femora, at least, black, yellow markings of tergites usually forming lateral spots.......... ... . 4.

4. Metanotum with a yellow spot and about two-thirds as long as dorsal aspect of propodeum, disk of propodeum with a lot of long bristle-like hairs; fourth tergite with a small yellow spot on each side **hesterae**, new species.

Metanotum black and about three-fourths as long as dorsal aspect of propodeum; disk of propodeum with dense appressed pile and without a bunch of bristle-like hairs, fourth tergite black. . .**fulvohirta** (Cresson).

CAMPSOMERIS (CAMPSOMERIS) LIMOSA (Burmeister)

Scolia limosa Burmeister, Abh. Naturf. Gesel. Halle, **1**: (pt. 4) 28. 1853. Female and male.

Elis limosa (Burmeister) Saussure, Ann. Soc Ent France, ser 3, **6**: 246. 1858.

Elis (*Dielis*) *limosa* (Burmeister) Saussure and Sichel, Catal. Species Gen. Scolia, 250. 1864. (Judging from variation allowed these authors had more than one species included under this name).

All the specimens of this species before me are from Mexico and the following definite localities are included: Huipulco (August 29, 1922, E. G. Smyth); Coapa, D. F. (August 18, 1922, E. G. Smyth), Oaxaca (September, 1923, E. G. Smyth, Chittenden no. 13670), District Federal (L. Conradt). These specimens show but little variation in structure or color, and agree well with the original description. The absence of a distinct, infuscate spot beyond the apex of the radial cell helps to distinguish this species.

Turner[8] synonymizes (*mexicana* Cameron) = *rokitanskyi* Dalla Torre with *limosa*. Judging from the original description by Cameron this cannot be correct. Cameron very definitely states that the apical segments of the abdomen have black hairs, while in *limosa* the apical segments of the abdomen are clothed with red hair.

Campsomeris (CAMPSOMERIS) **completa**, new species

This species comes nearest to *limosa* (Burmeister) but the differences given in the above key should make it easy to distinguish the two forms. The complete yellow bands on the tergites and general habitus suggests relationship with certain of the species which have the pubescence of the head and thorax pale and of the apical tergites black. The color of the pubescence is distinctive and until the species of the other group have been carefully studied it is impossible to point out the relationships in this direction.

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[8] Ann. Mag. Nat. Hist. ser. 8, **8**: 624. 1911.

Female.—Length 16 mm. Clypeus gently convex, covered with coarse longitudinal wrinkles; frons, vertex and occiput smooth with only a few widely scattered punctures; basal joints of the flagellum spinose at apex beneath; pronotum with close, distinct punctures; mesoscutum with large, distinct, rather close punctures except over a small median area; scutellum smooth, with a median longitudinal impressed line and a few large punctures laterally; metanotum with large distinct punctures on basal portion, its median length about two-thirds the median length of dorsal aspect of propodeum; posterior face of propodeum sloping, not distinctly separated from the dorsal aspect, the median part smooth and with only a few scattered punctures, the lateral parts with small punctures dorsally; dorsal aspect of propodeum with uniform, distinct, close punctures; tergites dull, with a few scattered setigerous punctures, sternites polished, with scattered setigerous punctures which are arranged in two rows on the third and are more numerous and closer on the base of second and apex of fourth, apical margin of radial cell oblique above, arched outwardly below and exceeding the second cubital cell. Black; first three tergites with transverse apical yellow bands, that on the first slightly indentate medianly, that on the second with two broad forward projections laterally, that on the third broadly produced forward medianly; tegulae, tarsi and spines on tibiae rufo-piceous, head, dorsum of thorax and apical two abdominal segments with long ferruginous hair, sides of thorax, femora and basal abdominal segments with long gray hair, appressed pile gray, not abundant, occurring only on sides of thorax and posterior aspect of propodeum Wings dusky hyaline, costal margin of fore wings ferruginous basally and followed by an elongate brown area beyond the radial cell; area inclosed by first cubital, radial and part of second cubital and median cells covered with brown hair.

One paratype shows a narrow yellow band on the fourth tergite and another is only 14 mm. long. Otherwise there is very little variation in the specimens in the type series.

Type locality. -Victoria, Mexico

Other localities.—Cerro, Mexico, and Guanajuato, Mexico.

Described from three (one type) females from the type locality collected March 16, 1922, by T. C. Barber and T. E. Holloway; from one female from Cerro, collected October 28, 1922, by E. G. Smyth, and one female from Guanajuato.

Type and four *paratypes.*—Cat. no. 40167 U. S. N. M.

CAMPSOMERIS (CAMPSOMERIS) TRICINCTA (Fabricius)

Tiphia tricincta Fabricius, Systema Entom., 354. 1775, Spec. Insect. **1**: 451. 1781, Mant. Insect. **1**: 280. 1787; Entom. Systema, **2**: 227. 1793; Systema Piez. 235. 1804.

Elis (*Campsomeris*) *tricincta* (Fabricius) Saussure, Ann. Soc. Ent. France, ser. 3, **6**: 246 and 248. 1858. Female.

Elis (*Dielis*) *tricincta* (Fabricius) Saussure and Sichel, Cat. Species gen. Scolia, 248 1864. Female and male. (Probably only for those specimens from the West Indies).

Campsomeris (*Campsomeris*) *pyrura* Rohwer, Proc. U. S. Nat. Mus. **49**: (no. 2105), 235. 1915. Female and male.

There seems to be nothing in the original Fabrician description of this species, or any of the subsequent descriptions by the same author, to justify the assumption of Saussure that it was described in the male. While the original description applies fairly well to the male, the male has more yellow markings on the thorax than is called for. The description does apply very exactly to the female and the original mention that the first joint of the antenna is ferruginous makes the identity nearly certain. In fact the mention of this character convinced me that the specimens to which I gave the name *pyrura* were really *tricincta*. There seems no reason to doubt the above synonymy.

The original description gives the locality as, "Habitat in America Dom. v. Rohr." and Saussure and others have considered that the species occurred in a number of the islands of the West Indies as well as in Mexico. It may be that the species does occur in many islands of the West Indies and in Mexico, but it seems more probable that in recording this distribution authors have confused other forms with *tricincta*. I have seen this species from the following localities.—Porto Rico: Mayaguez (types of *pyrura*), Mamayes Santa Rita, San Juan, Maricao, Arecibo, Adjuntas, Manati, Aibonito, Naguabo, Cayey, and Barros. Haiti: Port au Prince.

Campsomeris (Campsomeris) **hesterae**, new species

It seems probable that this species will be found in some collections under the name *limosa* (Burmeister) as the variation permitted for *limosa* by Saussure indicates they had more than one species under that name. Besides differing from *limosa* by the characters mentioned in the above key, the species may be separated from *limosa* by the distinct black mark which occurs in the fore wing beyond the end of the radial cell. This new species is more closely allied to the West Indian *fulvohirta* (Cresson) and may be found to vary so as to be distinguished from Cresson's species with difficulty. The material before me can be easily distinguished by the characters given in the foregoing key.

Female.—Length 18 mm. Head smooth with only a few scattered punctures, these closer on the vertex, clypeus convex, smooth, with punctures only basally, apical joint of antenna shorter than the two preceding, truncate apically; pronotum with close, distinct punctures, mesoscutum smooth medianly, laterally with close, distinct punctures; scutellum smooth, with a few large, distinct punctures laterally and basally, metanotum with distinct punctures along basal margin, two-thirds as long medianly as the median dorsal aspect of the propodeum, propodeum truncate posteriorly, the posterior aspect smooth, perpendicular and distinctly differentiated from the dorsal aspect, dorsal aspect of propodeum with close, uniform, rather large punctures, not produced medianly or separated from the posterior aspect by a carina or ridge; tergites dull, with a few scattered setigerous punctures; sternites shining, smooth, the second with many rather close punctures basally, remaining sternites with scattered setigerous punctures, radial cell oblique apically and exceeding the second cubital cell. Black; median spot on metanotum, lateral spots on first four tergites (those on second and third narrower laterally), apices of anterior femora beneath and bases of anterior tibiae exteriorly yellow, tegulae, tibiae and tarsi rufo-ferruginous; head, dorsum of thorax, apical margins of tergites, all of fifth and sixth tergites, the three apical sternites and tibiae and tarsi clothed with long ferruginous hair; sides, venter of thorax and dorsal aspect of propodeum with fine appressed, pale golden pile; hairs of sides of thorax, femora, base of first tergite and basal sternites pale yellow. Wings dusky hyaline, costal margin ferruginous basally, beyond the radial cell with an elongate subviolaceous spot; area inclosed by the first cubital and radial cells clothed with long dark brown hair.

The paratype from Guatemala is 20 mm. long. One paratype from Venezuela is 17 mm. long. Another paratype from Venezuela is 14 mm. long, has two small yellow spots on the scutellum and two yellow spots on the pronotum. A paratype from "Ecua" is 22 mm. long and has the spots on the first three tergites connected forming complete bands, those on tergites two and three being deeply emarginate medianly.

Type locality. Tucuche, Trinidad, British West Indies.

Other localities.—Cayuga, Guatemala, Las Adjuntas, Venezuela, "Ecua" (Ecuador).

Described from two females (one type) from the type locality collected May 31, 1925, by Hester M. Rohwer, one female from Guatemala collected June, 1915, by W. Schaus, three females from Venezuela collected June 29 and 30, 1926, and July 12, 1926, by H. E. Box, and one female from "Ecua" from C. F. Baker collection.

Type and five *paratypes.* Cat. no. 40168 U. S. N. M.

One paratype returned to H. E. Box.

The material collected by Mr. Box was sent under his number "E" and accompanied by a note stating that the species had been collected at Guatire (300 meters), Venezuela; that it frequented flowers of *Chibadium*, *Melochia* and (?) *Wedelia*, that it had been introduced into Porto Rico and had arrived there alive and oviposited regularly on grubs of *Lachnosterna portoricensis.*

CAMPSOMERIS (CAMPSOMERIS) FULVHIRTA (Cresson)

Scolia (*Elis*) *fulvohirta* Cresson, Proc. Ent. Soc. Phila., 4: 119. 1865. Female and male.

In two of the females from Santiago, Cuba, before me the pronotum is entirely black. Three females from Santiago, Cuba; one female and one male from Taco Taco, Cuba, April 1–6, 1922. The last two mentioned specimens agree almost exactly with the original description. Also one male from Portland, Jamaica, determined by W. J. Fox.

Two females collected at Miami, Florida, May, 1917, by W. M. Mann are assigned here. They differ from the Cuba specimens in having the yellow spots on the tergites somewhat smaller and in having the third sternite black.

Genus ELIS Fabricius

Elis caracasana, new species

The species is probably more closely allied to the species *toluca* (Cameron), *centralis* (Cameron) and *parvimaculata* (Cameron), but it differs from these species in having the abdomen black except for a yellow band on the first tergite. It also resembles *montivaga* (Cameron), but besides the difference in color of the abdomen, it may be distinguished from Cameron's description in having the basal median area of the propodeum not roughened. The large spines on the legs are whitish instead of being rufous The species is rather characteristic and may readily be recognized by its dark color, the infuscated costal margin of the wing and the coarse sculpture of the frons.

Female.—Length 17.5 mm Clypeus with large, irregular, sometimes confluent punctures, anterior margin almost without sculpture and nearly truncate; frons with coarse, irregular, sometimes confluent punctures and with distinct, deep, impressed line from between bases of antennae to almost the anterior ocellus, area surrounding the ocelli and vertex shining, with large, scattered punctures; distinct transverse groove behind posterior ocelli, posterior orbits smooth but with a few punctures along the hind margin, dorsal aspect of the pronotum opaque, granular and in addition with large, irregular, sometimes confluent punctures, mesoscutum bipunctate, the large punctures widely distributed and in the posterior part of the median area they are elongate; scutellum unipunctate with large, scattered punctures, dorsal aspect of the propodeum opaque, finely granular, with no distinct area set off by large punctures; posteriorly the dorsal aspect is irregularly wrinkled and this irregular wrinkling extends onto the sides of the posterior aspect, posterior aspect with the median area with dorsad-ventrad aciculations, mesepisternum with large, close, distinct punctures, sides of the propodeum with oblique rugae and with the areas between the rugae aciculate, first tergite with small, separate punctures, the second, third and fourth tergites with the punctures slightly larger and closely crowded together; the fifth tergite bipunctate but the small punctures rather inconspicuous and the larger punctures not much larger than those on the posterior margin of the fourth tergite, pygidium longitudinally striate for its entire length, sternites with large, scattered punctures near their apical margins, inner calcarium of the posterior tibia strongly curved basally and with a prominent tooth at the end of the curved portion; fourth abscissa of the cubitus subequal in length with the second intercubitus and shorter than the third abscissa of the radius, but slightly longer than the fifth abscissa of the cubitus Black, head, thorax and legs and ventral part of abdomen with scattered, glistening white hairs, the ventral part of the anterior face of the first tergite with a patch of long white hair; first and second tergites with a faint violaceous reflection, median posterior spot on the scutellum, metanotum medianly, a median longitudinal line on dorsal aspect of propodeum, lateral posterior angles of propodeum, oblique spot on side of propodeum, a transverse band on the first tergite medianly (dilated at the sides) yellow, wings subhyaline, the costal margin deeply infuscated and with a violaceous tinge, venation black

Paratypes show the species may vary in size from 18 to 12 mm., that the oblique yellow spot on the sides of the propodeum may be wanting, and that there may be elongate yellow spots on the sides of the third tergite basally.

Described from eight females (one type) collected by Harold E Box in July, 1926, at Las Adjuntas, near Caracas, Venezuela, 960 meters above sea level, on flowers of *Chbadium surinamense* and *Melochia caracasana.*

Type and paratypes.—Cat. no. 40239 U. S. N. M.

One paratype returned to sender.

SCIENTIFIC NOTES AND NEWS

The American Geophysical Union will hold its eighth annual meeting April 28 and 29, 1927, at the National Academy of Sciences, 21st and B Streets, Northwest, Washington, D. C., with the following schedule of meetings.

Thursday, April 28.—9:30 a.m. to 12:30 p.m., Sections of Geodesy and Terrestrial Magnetism and Electricity.—2:30 p.m. to 5:30 p.m., Sections of Volcanology and Oceanography.

Friday, April 29.—9:30 a.m. to 12:30 p.m., Sections of Meteorology and Seismology.—2:30 p.m. to 5:30 p.m., General Meeting of the Union.

New York University is now arranging for the installation, in its new Daniel Guggenheim School of Aeronautics, of a wind tunnel which will represent the most up-to-date equipment in this country for testing airplane models. It is estimated that air velocities in the tunnel will exceed 100 miles per hour.

The Petrologists' Club met at the Geophysical Laboratory on February 15. **James Gilluly** reviewed Twenhofel's *Treatise on sedimentation*, and J. B. **Mertie** reviewed Tarr's *Origin of chert and flint*, adding new observations of his own on chert formations in Alaska. L. **LaForge**, in an informal communication, showed a fragment of vein quartz containing unusual casts of a pyroxene, some of which completely penetrated the block.

Dr **Robert H. Lombard** resigned from the Geophysical Laboratory on March 1, to join the research laboratory of the Norton Company, manufacturers of grinding wheels and refractory products, at Worcester, Massachusetts.

Mr. O. W. **Torreson** sailed from New York for Peru on February 17 to relieve Mr. R. H. Goddard who has been in charge of the Huancayo Magnetic Observatory two years.

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OCEANOGRAPHY.—*The tide at Tahiti.*[1] H. A. MARMER, Coast and Geodetic Survey.

Particular interest attaches to the tide at Tahiti since this island furnishes a striking exception to the general rule that "the tide follows the moon." Instead of coming later each day by about 50 minutes, high water here generally comes about noon and midnight and low water about six o'clock in the morning and six o'clock in the evening.

Precise data with regard to the tide at Tahiti have been wanting. Only short series of observations appear to have been made, and these, for the greater part, a number of years ago. Recently, however, at the instance of the U. S. Hydrographic Office an excellent series of automatic tide records covering several years has been secured by Mr. Harrison W. Smith of the Massachusetts Institute of Technology, who was sojourning in Tahiti. The tide gauge was installed in Papeari Harbor on the southern coast of Tahiti, in latitude 17°45′S., longitude 149°22′W.

A harmonic analysis of a year of these observations has been made at the Coast and Geodetic Survey, a series of hourly heights 369 days in length beginning Feb. 1, 1924, being used. The results derived from the direct analysis were cleared for the effects of other components, the analysis and clearance being made in accordance with the procedure given in Harris' *Manual of Tides* and in Schureman's *Harmonic Analysis and Prediction of Tides.* The results derived are given in Table 1.

Several of the lesser components were derived, not from analysis, but by inference from other components. Such inferred values are enclosed in parentheses. The formulae used for inferring the amplitudes and epochs of these components are as follows: $2N = 0.133N_2$, $2N^\circ = 2N_2^\circ - M_2^\circ$; $R_2 = 0.008S_2$, $R_2^\circ = S_2^\circ$; $T_2 = 0.059S_2$, $T_2^\circ = S_2^\circ$; $\lambda_2 = 0.007M_2$, $\lambda_2^\circ = S_2^\circ - 0.536\,(S_2^\circ - M_2^\circ)$;

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[1] Received February 10, 1927

$\mu_2 = 0.024M_2$, $\mu_2^\circ = 2M_2^\circ - S_2^\circ$; $\nu_2 = 0.194N_2$, $\nu_2^\circ = M_2^\circ - 0.866(M_2^\circ - N_2^\circ)$.

From the harmonic constants above, it is seen that the tide at Tahiti is of the semidaily type, the ratio of $K_1 + O_1$ to M_2 being 0.29. The peculiar behavior of the tide here is evidenced in the relatively large value of S_2 as compared with M_2, the ratio being 0.88. The ages derived from these constants are: phase age 29 hours, parallax age −4 hours, and diurnal age −14 hours. The spring range, from the harmonic constants, is 1.1 feet, and the neap range 0.1 foot.

TABLE 1.—HARMONIC CONSTANTS, TAHITI

COMPONENT	H	κ	COMPONENT	H	κ
	feet	°		*feet*	°
K_1	0.030	278	O_1	0.048	293
K_2	0.075	20	P_1	0.013	253
L_2	0.010	1	Q_1	0.014	290
M_1	0.003	115	R_2	(0.002)	(20)
M_2	0.291	351	S_1	0.005	88
M_3	0.008	105	S_2	0.255	20
M_4	0.012	136	S_4	0.002	149
M_6	0.006	122	T_2	(0.015)	(20)
M_8	0.002	148	λ_2	(0.002)	(4)
N_2	0.061	353	μ_2	(0.007)	(322)
2N	(0.008)	355	ν_2	(0.012)	(352)

A nonharmonic analysis from the tabulation of the high and low waters, gives a mean range of 0.78 foot, a spring range of 0.97 foot, and a neap range of 0.58 foot. It will be noted that the mean and the spring ranges, from the high and low waters, do not differ much from the corresponding ranges derived from the harmonic constants. The neap range, however, from the high and low waters is considerably greater. Undoubtedly this is to be ascribed to the relatively large effects of disturbances due to meteorological conditions on a tide of such small range. From the high and low waters the lunitidal intervals derived are 12^h09^m for the high water, and 5^h53^m for the low water.

Since S_2 is somewhat smaller than M_2 it is obvious that the oft-repeated statement that the tide at Tahiti comes at the same time every day, is only a rough approximation. The tabulations show that there is some progression in the time of tide from day to day. This progression is considerably less than 50 minutes about the time of spring tides and considerably more about the time of neap tides.

At spring tides high water comes about noon and midnight, and low water about six o'clock both morning and afternoon. At spring tides the tide has its greatest range and is therefore most noticeable while at neap tides the times of high and low water are difficult to determine. Apparently, therefore, the characteristics of the spring tides here have been taken as the average characteristics.

BOTANY.—*New plants from Central America.*—VII.[1] PAUL C. STANDLEY, U. S. National Museum.

The new species described on the following pages are mostly plants collected by myself in Costa Rica during the past two years. They include representatives of four South American genera now reported for the first time from North America: *Puya* and *Greigia* of the Bromeliaceae; *Ophiomeris*, a curious member of that small family, Burmanniaceae, related to the orchids; and *Panopsis*, of the Proteaceae. One of the new species described, a *Brunellia*, is a Mexican tree.

Several of the descriptions have been contributed by other writers—that of a Salvadorean *Agave* by Dr. William Trelease; those of three Panamanian Caesalpiniaceae by Dr. J. N. Rose; and those of a new *Scutellaria* and a *Mendoncia* by Mr. Emery C. Leonard.

Puya dasylirioides Standl., sp. nov.

Plants large, terrestrial, 1–2.5 m. high, leaves mostly in a large dense basal cluster, stiff, 30–60 cm. long and larger, at base (above the sheaths) about 5 cm. wide, evenly tapering to the long-attenuate subulate apex, thick, finely striate, yellow-green, glabrous on the upper surface, beneath finely and closely whitish-lepidote; leaf-margins armed with sharp-pointed ascending blackish broad-based spinose teeth 4–5 mm. long and 1–4 cm. apart, the tip of the blade often unarmed; leaf-sheaths somewhat inflated but hard, dark brown, 7–8 cm. wide, the upper part of the sheath armed with minute close-set teeth; leaves of the stem similar to the basal ones but shorter, decreasing in size upward, the uppermost unarmed or nearly so and with thin brown papery sheaths, uppermost bracts of the stem 7–8 cm. long, much exceeding the internodes, loosely imbricate, abruptly acuminate into an ensiform blade 1.5–2 cm. long, sparsely arachnoid-villous with short whitish hairs, inflorescence spikelike, 30 cm. long or longer, 5–7 cm. thick, very dense and many-flowered; floral bracts similar to those of the stem but shorter, slightly exceeding the flowers, thin, dark brown, subulate-acuminate, short-villous; partial inflorescences few-flowered, about 3 cm. long, dense, the pedicels very thick, 1 cm. long, thinly brownish-tomentose; sepals 12 mm. long, ovate-

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oblong, narrowed to the obtuse apex, striate, thinly tomentose; capsule subglobose, 3-sulcate, about 12 mm long and broad, rounded at base and apex, glabrous, seeds very numerous, the body blackish brown, 2 mm long, longitudinally striate and pitted between the striae, the wing whitish.

Type in the U. S National Herbarium, nos. 1,252,726–1,252,727, collected in the Laguna de la Chonta, northeast of Santa María de Dota, Province of San José, Costa Rica, altitude 2,100 meters, Dec. 18, 1925, by Paul C. Standley (no 42334). Juvenile plants (no 43653) collected in the paramos of the Cerro de las Vueltas, at 3,000 meters, probably are referable to the same species I did not see any adult plants in the latter region

Puya dasylirioides is the most conspicuous plant of the Laguna de la Chonta, which is a sphagnum bog of several acres, occupying probably an old crater, and inclosed on all sides by dense wet forest The plants grow in great numbers everywhere except in the deep water, their tall stiff stems (all in fruit in December) suggesting mullein stalks. This lake is one of the most remarkable localities from a botanical standpoint that I have ever seen. It yielded a substantial number of curious plants that I have not found elsewhere in Costa Rica.

The genus *Puya*, represented in the high mountains of South America by over 40 species, has not been reported from North America. The Costa Rican plant, according to Mez's monograph, is related to the imperfectly known *P. Goudotiana* Mez, of Bogotá The leaves, with their hard broad bases and narrow spine-margined blades, strongly suggest those of some species of *Dasylirion* They show upon their faces the impressions of the spiny margins of the adjacent leaves, produced by mutual pressure in the dense rosette which they form, a feature characteristic of the genus *Dasylirion.*

Greigia sylvicola Standl., sp. nov.

Plants large, terrestrial, arising from elongate rootstocks, the stems stout, 1–1.5 m high, densely leafy, leaves linear, 130 cm. long or shorter, 12–18 mm. wide, long-attenuate to the apex, somewhat dilated at base into a short, slightly inflated sheath 3–4 cm. wide, sheaths densely dotted with large, closely appressed, brown scales, the blades with a few minute brown scales but appearing glabrous, finely striate, thin, when fresh bright green; margins of the sheath unarmed, those of the blade just above the sheath (for 15–18 cm.) armed with numerous antrorse, dark brown, spinose teeth 1.5–3 mm long and 8–22 mm apart, the margins along the middle of the blade for the greater part of its length unarmed or with minute teeth, the apex of the blade for 20–25 cm finely and densely spinose-serrate; inflorescence terminal, nearly hidden among the leaves, headlike, many-flowered, about 5 cm long and broad, borne on a stout bracted stalk 4 cm. long; bracts equaling the sepals, green, linear-lanceolate to (outer ones) ovate, thin, long-acuminate, sparsely brown-lepidote, entire below, toward the apex densely serrate with coarse brown broad-based incurved teeth; flowers sessile; ovary turbinate, 3-angled, 10–15 mm. long, 5 mm. broad; sepals free, green, lanceolate, about 2 cm long, long-acuminate, entire, spinose at apex, sparsely brown-lepidote, immature fruit about 1.5 cm. long and 1 cm thick, many-seeded.

Type in the U. S. National Herbarium, no. 1,252,555, collected in forest near Laguna de la Escuadra, northeast of El Copey, Province of San José, Costa Rica, altitude about 2,200 meters, Dec. 16, 1925, by Paul C Standley (no. 41975).

This bromeliad is frequent in the high mountains of the Cantón de Dota, but although locally abundant, fertile plants were found only once. The plants grow in the densest and wettest forest of oak and bamboo, usually in the darkest swamps or in running water, associated with begonias and Lobeliaceae. The following sterile specimens, all from the same region, are referred to this species:

COSTA RICA: Near Finca La Cima, above Los Lotes, alt. 2,400 m., *Standley* 42797. Laguna de la Chonta, northeast of Santa María de Dota, alt. 2,100 m , *Standley* 42357. Cerro de las Vueltas, alt. 3,000 m., *Standley* 44009.

The genus *Greigia* (Bromeliaceae) has not been reported north of Colombia. It consists of half a dozen species which range southward into Chile. The Costa Rican plant is related, according to description, to *G. albo-rosea* (Griseb.) Mez, of Venezuela, which has broader leaves and larger flowers

Vriesia disticha (L) Standl.

Renealmia disticha L. Syst. Nat. ed. 10 974 1759.
Tillandsia heliconioides H. B. K. Nov. Gen. & Sp. **1**: 234. 1815.

Pogomesia leiocalyx (Clarke) Standl.

Pogomesia Raf. (1836) is the oldest name for the genus of Commelinaceae to which the name *Tinantia* Scheidw. (1839) has been more generally applied. *Tinantia leiocalyx* Clarke, Bot. Gaz **18**: 211. 1893.

Pogomesia erecta (Jacq.) Standl.

Tradescantia erecta Jacq. Coll. Bot **4**: 113 1790
Tinantia erecta Schlecht. Linnaea **25**: 185 1852.

Agave compacta Trelease, sp. nov.

Section *Guatemalenses*. Acaulescent, not cespitose. Leaves gray-green, not transversely banded, fleshy, oblanceolate-obovate, upcurved above the thick contracted base, acuminate, plicate upwards, smooth, about 100 cm. long and 25 cm. wide; spine light brown, dull, smooth, straight, acicular, involutely grooved from above the middle with acute edges, decurrent for more than its own length, about 50 by 5 mm , teeth brown, 10-20 mm. apart, scarcely 3 mm. long in the middle and reduced upwards and downwards, triangular from lenticular bases, nearly straight, the margin straight between them. Inflorescence densely paniculate, ovoid, 2.5 m. tall and half as broad, the scape about equaling the leaves, the horizontal branches few-parted at the end, their divisions very compactly flowered; pedicels scarcely 10 mm. long; flowers yellow, about 40 mm long, ovary 20 mm. long, equaling the perianth, oblong; tube openly conical, about 5 mm. deep; segments 15 mm long, shorter than the ovary; filaments inserted toward the throat, 35 mm. long, more than twice as long as the segments. Fruit unknown, freely bulbiferous.

Type in the U. S. National Herbarium, nos. 1,208,021–1,208,024, taken from a plant cultivated in the Patio de Ensayos, San Salvador, Salvador, by Salvador Calderón (no. 2251).

Unique in its short compact panicle, commencing at the height of the leaf tips.

Heliconia Lankesteri Standl., sp. nov.

Plants of medium size for the genus, 1.5–2.5 m. high; petioles long and slender, glabrous, the sheaths glabrous, tinged with red; leaf-blades oblong-elliptic, about 75 cm. long and 25 cm. wide, abruptly short-acuminate, rounded at base, thin, glabrous, green on both surfaces, inflorescence erect, pedunculate, deltoid, about 30 cm. long and wide, glabrous throughout or nearly so, the rachis thick and stout, conspicuously zigzag, the internodes 1-3 cm. long; bracts about 16, slightly upcurved from near the base, cherry-red or dark yellow, long-attenuate to an obtuse tip, closely set, the upper basal margin of one bract nearly reaching the base of the next higher bract; lowest bract as much as 32 cm. long, the middle ones about 12 cm. long, strongly concave, the bases 1.5–2.5 cm. high; flowers numerous, dark yellow or red, 4.5 cm. long, glabrous; fruits pedicellate, partly exserted from the bracts, subglobose, about 1 cm. in diameter.

Type in the U. S. National Herbarium, nos. 1,228,683–1,228,684, collected in wet forest at La Estrella, Province of Cartago, Costa Rica, March 26, 1924, by Paul C. Standley (no. 39494). To this species may be referred the following additional collections:

COSTA RICA: Vicinity of Orosi, Prov. of Cartago, *Standley* 39927. Forests of El Copey, Prov. of San José, alt. 1,800 m., *Tonduz* 11821.

This plant is related to *H. adflexa* (Griggs) Standl. (*Bihai adflexa* Griggs)[8] a Guatemalan species which differs in its pubescent rachis and narrower, much more distantly spaced bracts.

The species is named for Mr. C. H. Lankester, in whose company I made the excursion to La Estrella, where the type was collected.

Heliconia tortuosa (Griggs) Standl.

Bihai tortuosa Griggs, Bull. Torrey Club **30**: 650. 1903.

Heliconia straminea (Griggs) Standl.

Bihai straminea Griggs, Bull. Torrey Club **42**: 327. 1915.

Ischnosiphon elegans Standl., sp. nov.

Plants erect, 1–1.5 m. high, much branched, the branches slender; leaf sheaths 4–14 cm. long, conspicuously nerved, puberulent or glabrate; petioles 2.5 cm. long or less, the lower portion puberulent or scaberulous, the callus terete, glabrous; leaf-blades oblong-ovate, 6–17 cm. long, 3–6.5 cm. wide, abruptly acuminate, obtuse or rounded at base and usually abruptly contracted, thin, green, glabrous, spikes solitary, short-pedunculate, 20–25 cm. long, 6–8 mm. thick, the internodes about 2 cm. long, thinly pilose with short white hairs; bracts usually 10, lanceolate, 3.5–4 cm. long, acute, green, appressed or ascending, coriaceous, thinly pubescent, especially near the margins, finely nerved; flower 1 in each bract, sessile, ovary glabrous; bractlets oblong-linear, 2.3 cm long, hyaline, rounded at apex and densely white-pilose; sepals narrowly linear, 2 cm. long, pilose; corolla white, the tube filiform, over 3 cm long, white-pilose, the lobes 1 cm. long, capsule cylindric, 1.5 cm. long, pilose at apex; seed and aril together 12 mm. long, 3 mm. thick, smooth, mottled with light and dark brown, the aril 3 mm long.

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[8] Bull. Torrey Club **42**: 325. 1915.

Type in the U. S National Herbarium, no. 1,253,581, collected in moist forest near Tilarán, Guanacaste, Costa Rica, altitude 600 meters, January, 1926, by Paul C. Standley and Juvenal Valerio (no. 44251). The following additional collections, all from Guanacaste, illustrate the same species·

COSTA RICA: Tilarán, *Standley & Valerio* 46623. Naranjos Agrios, alt. 600 m., *Standley & Valerio* 46487, 46460. El Silencio, *Valerio* 64.

The only other Central American species, which grows in Panama, *I. leucophaeus* (Poepp & Endl) Koern , has large broad leaves, whitish beneath, and clustered spikes. The Costa Rican plant is related to *I. gracilis* (Rudge) Koern., of Brazil and the Guianas, a species with narrower leaves, more slender spikes, and seeds twice as large

Ophiomeris panamensis Standl., sp. nov.

Plant hyaline, white, glabrous, the stem about 6 cm. long, 1 3 mm. thick, naked, subflexuous; flower solitary, terminal, 2 or 3-bracteate at base, the bracts lance-oblong to ovate, 1 5–3 mm long, appressed, perianth campanulate, gibbous, 15 mm. long in its greatest length, about 10 mm. wide, at base abruptly narrowed, the orifice oblique, 8 mm broad; corolla limb 6-parted, the 3 outer lobes short, ovate, and 3 inner ones about 3 cm. long, flexuous, filiform, dilated at base, spirally included in bud; stamens 6, equal, free, opposite the perianth lobes, the filaments deflexed, expanded into petaloid blades, these emarginate at apex, anthers small, 2-celled, the cells collateral, almost parallel, longitudinally dehiscent, ovary adnate to the perianth, free at apex and rounded, 1-celled. many-ovulate; style 1 5-2 mm. long, the 3 stigmas short, erect.

Type in the U S. National Herbarium, no 1,269,478, collected along the Pearson Trail on Barro Colorado Island in Gatún Lake, Canal Zone, Panama, July 11, 1925, by C. W. Dodge (no. 3484). Collected also along the Shannon Trail on the same island, July 17, 1925, *Dodge* 3460.

This is the first representative of the family Burmanniaceae, subfamily Thismieae, to be reported from tropical North America One other member of the group, *Sarcosiphon americanus* (Pfeiffer) Schlechter, was found a few years ago near Chicago, a truly remarkable record, inasmuch as the other plants of the family are tropical in distribution.

The available material of the Panama plant is very scant, and the plant is so delicate that in the dried state it is difficult to determine its characters satisfactorily. According to the most recent treatment of the group, by Schlechter, it seems to agree best with the genus *Ophiomeris*, of which two species, both Brazilian, are known. In *O. macahensis* Miers the orifice of the perianth is small and lateral, while in *O panamensis* it is merely oblique, and much larger. In the latter, also, the anther cells are much less divergent than in the Brazilian species.

It is strange that this plant has not been found in Panama by other collectors, especially since Prof. Dodge states that it was plentiful on Barro Colorado in the summer of 1925. It may well be that it is an ephemeral plant, found only when conditions are exceptionally favorable, and having a growth period of very few weeks.

Myrica phanerodonta Standl., sp. nov.

Shrub 2.5–3.5 m. high, the older branches subterete, blackish, the young ones stout, sparsely or densely pubescent or glabrate, gland-dotted, densely leafy, the internodes about 1 cm. long, petioles stout, 2–6 mm. long, puberulent, leaf-blades obovate or oblong-obovate, 3–6 cm. long, 1.3–2.8 cm. wide, obtuse to rounded at apex, acuminate to broadly cuneate at base, coriaceous, serrate, the teeth about 10 on each side, salient, scarcely 1 mm. long, the blades deep green above, puberulent along the costa, slightly paler beneath, rather sparsely gland-dotted, puberulent on the prominent costa or glabrate, the lateral nerves very slender, plane or slightly elevated, straight or subarcuate, extending to the margin, staminate aments axillary, solitary, sessile, 10–18 mm. long, 4 mm. thick; anthers 1 mm. long.

Type in the U. S. National Herbarium, no. 799175, collected on the summit of the Volcán de Poas, Costa Rica, altitude 2,644 meters, November, 1896, by A. Tonduz (no. 10785). The following collections represent the same species.

COSTA RICA: Upper slopes of Volcán de Poás, *Standley* 34884. Cerro de Zurquí, Prov. Heredia, alt. 2,200 m., *Standley & Valerio* 50423.

Related to *M. parvifolia* Benth., of Colombia, which lacks the numerous salient teeth that mark the leaves of *M. phanerodonta*.

MYRICA PUBESCENS Willd. Sp. Pl. 4: 746. 1805.

Heretofore only a single species of *Myrica*, *M. mexicana* Willd. (*M. xalapensis* H. B. K.), has been known from Central America. This is a common and widely distributed plant, frequent in Costa Rica. It is strange that there has not been collected in Costa Rica long ago the Colombian *Myrica pubescens* Willd., a well-marked species, common in central Costa Rica, and occurring in the vicinity of both Cartago and San José, which are not exactly unexplored regions. The name "encinillo" is applied to the tree. The following collections of *M. pubescens* are in the National Herbarium:

COSTA RICA: Vara Blanca to La Concordia, *Maxon & Harvey* 8477. Río Reventado, Cartago, *Standley & Valerio* 49386. Between Aserrí and Tarbaca, *Standley* 34058, 41356. Quebradillas, *Standley* 43018. Santa María de Dota, *Standley* 41574. Cerro de Piedra Blanca, above Escasú, *Standley* 32457, 32586.

Panopsis costaricensis Standl., sp. nov.

Large shrub or tree, 5–10 m. high, the branchlets glabrate, densely leafy, brownish, bearing numerous pale elevated lenticels, leaf buds densely ferruginous-sericeous; petioles stout, 4–10 mm. long, glabrous; leaf-blades oblanceolate-oblong or obovate-oblong, 6–20 cm. long, 2–6 cm. wide, obtuse or rounded at apex, cuneately narrowed at base, subcoriaceous, lustrous, entire, concolorous or when dry sometimes brownish beneath, the venation conspicuous on both surfaces, coarsely reticulate, the principal lateral nerves about 6 on each side, very irregular; flowers yellowish white, racemose, the racemes few, forming a terminal panicle, the rachises 8–13 cm. long, many-flowered, floriferous nearly to the base, thinly pilose with minute, mostly appressed, brownish hairs; bracts linear-subulate, about 6 mm. long; pedicels divaricate, slender, 3-4 mm. long, pubescent like the rachis; perianth lobes linear, 5–6 mm. long, pilose outside with sparse minute appressed hairs; hypogynous scales united to form a membranaceous 4-denticulate cup about 0.6 mm. high; ovary densely brown-hirsute; style 4 mm. long, glabrous, clavate at apex; fruit broadly ovoid, only slightly asymmetric, subsessile, about 4.5 cm. long and 3 cm. in diameter, obtuse at base, abruptly contracted to the large mammiliform apex, smooth, glabrous.

Type in the U. S. National Herbarium, no. 861785, collected on hills of Santiago, near San Ramón, Costa Rica, in flower, May 1, 1901, by A. M. Brenes (no. 14303). The following additional collections are referred here:

COSTA RICA: Fraijanes, Prov Alajuela, alt 1,600 m., *Standley & Torres* 47440. La Ventolera, on the southern slope of Volcán de Poás, alt. 1,700 m., *Standley* 34567.

The other species of *Panopsis* are South American, this being the first one reported for North America. The Costa Rican tree resembles in foliage characters Bolivian specimens collected by Bang and distributed as *P. Sprucei* Meisn., but the Bolivian species has a much shorter style and copious pubescence on branches and leaves.

Brunellia costaricensis Standl., sp. nov.

Medium-sized tree with rounded crown, the branchlets stout, glabrous or at first very sparsely pilose, leaves opposite, pinnate, the leaflets 7 to 10 (terminal leaflet often absent), the petiole and rachis together 8-28 cm. long, stout, subterete, glabrous, petiolules stout, 8–14 mm long, shallowly sulcate above, glabrous; leaflets oblong, 7.5–13.5 cm. long, 2.5–5.5 cm. wide, rounded or obtuse at apex and abruptly short-cuspidate (cusp 5–6 mm. long, obtuse), at base broadly rounded to obtuse, somewhat unequal, remotely and very shallowly appressed-crenate, coriaceous, deep green above, glabrous, beneath pale, when very young rather densely sericeous with minute, closely appressed hairs, but soon glabrate, the costa impressed above, salient beneath, the lateral nerves very prominent beneath, 15–18 pairs, ascending, nearly straight, extending to the margin; panicles axillary, rather dense, many-flowered, about 16 cm. broad, much branched, pedunculate, the branchlets densely pilose with minute, ascending or subappressed hairs, the pedicles stout, 4–6 mm. long, jointed below the middle; calyx lobes 5, ovate to elliptic-oblong, 2–2.5 mm. long, acute or acutish, minutely sericeous on both surfaces; carpels of the fruit 4 or 5, when fully mature 3 mm. high, sessile, densely and minutely sericeous, the stout style lateral; seeds dark red-brown, very lustrous, smooth, 2.5 mm. long.

Type in the U. S. National Herbarium, no. 1,306,244, collected in wet forest at Yerba Buena, northeast of San Isidro, Province of Heredia, Costa Rica, altitude about 2,000 meters, February, 1926, by Paul C. Standley and Juvenal Valerio (no. 49900). The species is represented by the following additional collections:

COSTA RICA: Yerba Buena, *Standley & Valerio* 49951. La Palma, alt. 1,460 m., *Tonduz* 12605 (*J. D. Smith* 7412).

This Costa Rican *Brunellia*, the only representative of the genus known from Central America, has been determined as *B. comocladifolia* Humb. & Bonpl., a species of Colombia and the Greater Antilles. The Colombian tree is strikingly different in its nearly sessile leaflets which are softly pubescent beneath with dense spreading fulvous hairs. Its carpels, also, are hispidulous.

Brunellia mexicana Standl., sp. nov.

Tree, the young branches stout, terete, glabrous, with short internodes; leaves opposite, pinnate, the leaflets 11 to 17, the petiole and rachis together 11–50 cm. long, slender, terete, glabrous or puberulent; petiolules 2–4 mm. long, puberulent or glabrous, leaflets oblong or lance-oblong, 6–14 cm. long, 2–4.5 cm. wide, acuminate or long-acuminate, at base somewhat oblique, rounded to obtuse, appressed-serrulate, subcoriaceous, deep green on the upper surface, short-pilose with appressed hairs along the nerves or glabrous, the costa impressed, beneath glaucous, when young velvety-pubescent, the pubescence in age mostly deciduous except along the nerves, the costa and lateral nerves prominent beneath, the latter about 19 pairs, arcuate, extending to the margin, panicles solitary in the leaf axils, about 15 cm. broad, densely many-flowered, the peduncles elongate, compressed, the branches densely tomentose, pedicels 4–7 mm. long, jointed near the base, calyx lobes 5, oblong-ovate, 2.5 mm. long, acutish, tomentulose on both surfaces, spreading in fruit, carpels of the fruit 4 or 5, at maturity 5 mm. long, compressed, the short stout style nearly basal, the carpels densely tomentose and hispid with short stiff hairs. seeds 2 mm. long, dark brown, scarcely lustrous.

Type in the U. S. National Herbarium, no. 1,265,699, collected at Tecomatla, Veracruz, Mexico, October, 1925, by C. A. Purpus (no. 10454).

The same species was collected in Oaxaca by Galeotti (no. 7247).

Brunellia mexicana is much closer to *B. comocladifolia* than to *B. costaricensis*. The Colombian species differs in the broader-based leaflets, green beneath and with prominent-reticulate secondary venation, and in the much smaller carpels. The pale under surface of the leaflets of *B. mexicana* is caused, perhaps, by a microscopic tomentum, or possibly by a waxy exudate.

Bauhinia Standleyi Rose, sp. nov.

Large woody vine, the stem often flattened and then 5 cm. or more broad; young branches with dense brown pubescence, tendrils slender, hairy: stipules small, broadly ovate to orbicular, 2 mm. long, hairy below, glabrous above, caducous; petiole 2–3 cm. long; leaf-blades broader than long, 3–5 cm. long, 2-lobed, sometimes cleft below the middle, the lobes rounded, 7 to 9-nerved, dull green, softly pubescent on both sides; inflorescence terminal, 4–5 cm. long, many-flowered, pubescent; bracts linear; pedicels slender, 10 mm. long or less, bearing 1 or 2 linear bractlets; calyx cup-shaped, 4–5 mm. long, the lobes 1–3 mm. long, linear, petals 5, very hairy below, 10–

12 mm. long, erect, greenish white, one of them with small purple spots; perfect stamens 10, glabrous; pods broadly spatulate, 6–7 cm. long, 2 cm. broad near the top, in age glabrate.

Type in U. S. National Herbarium, no. 1,152,798, collected by Paul C. Standley, near Punta Paitilla, Province of Panama, Panama, December 7, 1923 (no. 26247). The following collections represent the same species:

PANAMA: Taboga Island, *Macbride* 2800, *Standley* 27908. Ancón, *Piper* 6031. Along the Corozal Road near Panama, *Standley* 23776. Around El Paraíso, Canal Zone, *Pittier* 2577. Vicinity of Penonomé, *Williams* 134.

Cassia Killipii Rose, sp. nov.

Procumbent herb with long slender branches, often 1 meter long, the short pubescence interspersed with spreading hairs and more or less viscid; stipules minute; leaflets 2 pairs, orbicular to short-oblong, 5–10 mm. long, rounded at apex, glabrous above or nearly so, pubescent beneath, strongly veined; flowers axillary and solitary or somewhat paniculate above; flower bud obtuse, densely long-setose, sepals 8–9 mm. long, obtuse; petals 11–13 mm. long, brick-red; ovary densely setose; fruit setose, 2 5 cm. long, 5 mm. broad.

Type in the U. S National Herbarium, no. 1,266,850, collected by E. P. Killip near the Tapia River, Province of Panama, Panama, December 9, 1917 (no. 3281). The following specimens are referable to this species:

PANAMA: Vicinity of Penonomé, *Williams* 104. Between Paso del Arado and Olá, Prov. Coclé, *Pittier* 5014. Along the Río Tapia, Prov. Panama, in savanna or on grassy slopes, *Standley* 28186, 30656.

Cassia pallidior Rose, sp. nov.

Low shrub, glabrous or nearly so; leaflets 12 pairs or fewer, narrowly oblong to orbicular, 1 5–3.5 cm. long, a little hairy when young but soon glabrate, very pale beneath, apiculate; stipules linear, caducous; gland between the lowest pair of leaflets large, clavate; inflorescence 2-flowered; peduncles and pedicels slender; flowers large, sepals thin, orbicular; petals orbicular to short-oblong, sometimes 3 cm. long, 3 of the anthers with long slender beaks, pod 12–15 cm. long, 5–6 mm. broad

Type in the U. S. National Herbarium, no. 676,583, collected by H. Pittier near Alhajuela, Panama, January, 1914 (no. 2343). The following collections also belong to this species:

PANAMA: Sabana de Alhajuela, *Pittier* 3465.

COSTA RICA: Río Virilla, Prov. San José, *Tonduz* 9824 (*J. D. Smith* 7007), 12714 (*J. D. Smith* 7437)

Tephrosia Heydeana (Rydb) Standl.

Cracca Heydeana Rydb. N. Amer Fl. **24:** 166. 1923.

Pavonia fruticosa (Mill.) Standl.

Sida fruticosa Mill. Gard. Dict ed. 8. *Sida* no. 18. 1768.
Pavonia typhalaea Cav. Diss. Monad. **3:** 134. 1787.

Pavonia Preslii Standl., nom. nov.

Malachra ovata Presl, Rel. Haenk. **2**: 125. 1835. Not *Pavonia ovata* Spreng. 1826.

Pavonia panamensis Standl.

Malache panamensis Standl. Contr U. S. Nat. Herb. **18**: 116. 1916.

Hybanthus guanacastensis Standl , sp. nov.

Shrub 1 5-4 5 m. high, the branches densely leafy, the older ones slender, terete, grayish, the young ones sparsely or densely puberulent; stipules 2.5-3 mm. long, broadly ovate, glabrous, the costa and basal portion indurate, the costa excurrent as a subulate mucro, the margins scarious, whitish, ciliolate: petioles 2-5 mm. long, glabrous. leaf-blades oblong to oblong-elliptic, 4-10 cm. long, 1.5-4 5 cm. wide, acute to long-acuminate, at base rounded to acutish and conspicuously oblique, thin, glabrous, rather remotely and irregularly serrate-dentate, the teeth callous-tipped, the venation prominent on both surfaces. flowers axillary, solitary, the pedicels 6-10 mm. long, slender, glabrous, jointed above the middle, sepals ovate, 2 mm. long, acute or obtuse, thin, greenish, glabrous but ciliolate; lower petal 6 mm. long, panduriform, broad and inflated at base, constricted above, then expanded into a short broad truncate blade, glabrous, the upper petals 4 mm. long; filaments broad, about equaling the villous anthers, the connective expanded into a large thin quadrate appendage; immature capsule 6 mm. long, orbicular, glabrous, rounded at apex, the persistent style 2 mm. long.

Type in the U. S. National Herbarium, no. 1,254,104, collected in wet mountain forest at Los Ayotes, near Tilarán, Guanacaste, Costa Rica, altitude about 700 meters, January 21, 1926, by Paul C. Standley and Juvenal Valerio (no 45423). To the same species are referred the following collections from Guanacaste.

COSTA RICA: Quebrada Serena, *Standley & Valerio* 46161, 46197. Los Ayotes, *Standley & Valerio* 45346.

Related to *H. mexicanus* Ging., which has flowers only half as large on much shorter pedicels.

Hybanthus tenuifolius (Dowell) Standl.

Calceolaria tenuifolia Dowell, Bull Torrey Club **33**: 550. *pl. 18.* 1906.

Hybanthus longipes (Dowell) Standl.

Calceolaria longipes Dowell, Bull. Torrey Club **33**: 551. *pl. 19.* 1906.

Hybanthus glaber (Dowell) Standl.

Calceolaria glabra Dowell, Bull. Torrey Club **33**: 552. *pl. 20.* 1906.

Hybanthus brevis (Dowell) Standl.

Calceolaria brevis Dowell, Bull. Torrey Club **33**: 552. *pl. 21.* 1906.

Hybanthus angustifolius (H. B. K.) Standl.

Ionidium angustifolium H. B. K. Nov. Gen. & Sp. **5**: 377. 1821.

Hybanthus riparius (H. B. K.) Standl.

Ionidium riparium H. B. K. Nov. Gen. & Sp. 5: 378. 1821.

Hybanthus nigricans (Dowell) Standl.

Calceolaria nigricans Dowell, Bull. Torrey Club 33: 554. 1906.

Hybanthus humilis (Rose & Dowell) Standl.

Calceolaria humilis Rose & Dowell, Contr. U. S. Nat. Herb. 10: 125. *pl.* 42. 1906.

Hybanthus Rosei (Dowell) Standl.

Calceolaria Rosei Dowell, Bull. Torrey Club 33: 555. *pl. 22.* 1906.

Xylosma Hemsleyana Standl.

Hisingera elliptica Clos, Ann. Sci. Nat. IV. 8: 226. 1857
Xylosma elliptica Hemsl. Biol. Centr. Amer. Bot. 1: 57. 1879. Not *X. elliptica* Tul. 1868.

Symplocos Johnsonii Standl., sp. nov.

Tree 18 m. high, the branchlets subterete, glabrous, bearing few large elevated lenticels; petioles stout, 12–18 mm. long, broadly channeled above, glabrous; leaf-blades oblong or elliptic-oblong, 11.5–22 cm. long, 4.5–8 cm. wide, abruptly acute, with obtuse tip, acute or acuminate at base, subcoriaceous, entire or essentially so, glabrous, lustrous above, the costa impressed above, prominent beneath, the lateral nerves very slender, about 14 on each side, arcuate-ascending, laxly anastomosing near the margin; inflorescence few-flowered, dense and congested, the flowers sessile, calyx-tube 2 mm. long, glabrous, the lobes broadly rounded, 2 mm. long, minutely ciliolate, otherwise glabrous; corolla 16 mm. long, the tube 8–9 mm. long, 2.5 mm. thick, the 5 lobes obovate or oblong, rounded at apex, glabrous; stamens very numerous, free above, equaling the corolla lobes, the filaments connate into a tube, very unequal, finely and densely papillose, not collected in recognizable fascicles, stout, abruptly contracted near the apex into a very slender tip, style 16 mm. long, densely hirsute below.

Type in the U. S. National Herbarium, no. 1,081,463, collected at Samac, Alta Verapaz, Guatemala, altitude 1,350 meters, October 20, 1920, by Harry Johnson (no. 874).

This species belongs to Brand's section *Symplocastrum*, subsection *Pseudoalstonia*, and in his key to the group, in the Pflanzenreich, runs at once to *S. quinduensis*, of Colombia. That species has much smaller leaves and a smaller corolla. Among the Central American species, *S. Johnsonii* is conspicuous because of its large leaves.

The collector reports that the flowers are rose-pink and very fragrant. It is a pleasure to be able to name this fine species for Mr. Johnson, who obtained in Alta Verapaz in 1920 one of the most interesting and most carefully prepared collections of plants ever made in Guatemala

Chelonanthus alatus (Aubl.) Standl.

Lisianthus alatus Aubl. Pl. Guian. 204. 1775.

Scutellaria argentata Leonard, sp. nov.

Tall slender herb (only the upper portion of plant available for study); stem dark purplish, glandular-pubescent, petioles 1–1.5 cm. long, densely glandular-puberulent, leaf-blades oblong-elliptic or oblong-obovate, obscurely panduriform, acuminate at apex, narrowly cordate at base, rather coarsely serrate with flat teeth, both surfaces bearing shiny silver dots, glabrous except the glandular-puberulent midrib and veins of the lower surface, the veinlets inconspicuously reticulate, flowers numerous, crowded in a terminal raceme about 8 cm. long; rachis strongly glandular-puberulent; bracts linear, 2–3 cm. long, about 0.5 mm. broad, obtuse, deciduous; pedicels 2–2.5 mm. long, glandular-puberulent; calyx 4 mm. long, the lobes reddish purple, glandular-pubescent, the crest small; corolla bright crimson, sparingly pubescent, 4–5 cm. long, the tube slender, 4 mm. broad at throat, gradually narrowed to 2 mm. at base, the upper lip much larger than the lower, the middle lobe rounded, deeply emarginate, curving over the stamens, the lateral lobes short, oblong, 25 mm. long, 8–9 mm. broad, the lower lip triangular, rounded, shallowly notched at apex, stamens didynamous, curved at tip, glabrous, the upper pair 2 mm. longer than the lower, the anthers of the upper pair 1-celled, oval, 1.25 mm. long, 0.75 mm. broad, those of the lower pair 2-celled, broadly ovate, 1.25 mm. long and broad, cordate at base, slightly emarginate at apex; style equaling the upper pair of stamens, curved at tip, glabrous, the stigma unequally 2-lobed, the lobes spreading, ovary glabrous, on a conical gynobase 1 mm. long and 1.5 mm. broad at base; nutlets not seen.

Type in the U. S. National Herbarium, no. 1,266,817, collected at La Florida, Costa Rica, in 1925, by C. H. Lankester.

This attractive plant is well marked by its long slender crimson flowers, glandular pubescence, and silvery-punctate leaves. The slightly panduriform leaf-blades suggest a relationship with *S. costaricana*, but that species can be separated easily by its smaller corolla and eglandular pubescence.

Gonzalagunia rudis Standl.

Duggena rudis Standl. Contr. U. S. Nat. Herb. **18**: 125. 1916.

Since there is some doubt as to the identity of the plant described as the type of the genus *Duggena*, it is preferable to use for this group of Rubiaceae the next older name, *Gonzalagunia*.

Pentagonia pubescens Standl.

Watsonamra pubescens Standl. Contr. U. S. Nat. Herb. **17**: 441. 1914.

The generic name *Pentagonia* Benth. has been rejected because of *Pentagonia* Vent. (1841), but the latter does not seem to be effectively published.

Pentagonia Donnell-Smithii Standl.

Watsonamra Donnell-Smithii Standl. Contr. U. S. Nat. Herb. **17**: 442. 1914.

Pentagonia Pittieri Standl.

Watsonamra Pittieri Standl. Contr. U. S. Nat. Herb. **17**: 443. 1914.

Pentagonia brachyotis Standl.

Watsonamra brachyotis Standl. Contr.U. S. Nat. Herb. **17**: 443. 1914.

Pentagonia gymnopoda Standl.

Watsonamra gymnopoda Standl. Contr. U. S. Nat. Herb. **17**: 444. 1914.

Pentagonia alfaroana Standl.

Watsonamra alfaroana Standl. Journ. Washington Acad. Sci. **15**: 287. 1925.

Cephaelis nana Standl.

Evea nana Standl. Journ. Washington Acad Sci. **15**: 105. 1925.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY

947TH MEETING

The 947th meeting, constituting the 56th annual meeting, was held in the Cosmos Club auditorium on December 11, 1926 It was called to order by President BOWIE at 8:19, with 46 persons present

The report of the Treasurer showed total receipts, $1753 08; disbursements, $1207.73, leaving a balance of $545 35. The report of the secretaries showed that 19 meetings were held during the year, several in conjunction with other societies.

The following officers were elected for the year 1927: *President*, J. P. AULT; *Vice-Presidents*, L. H. ADAMS and P. R. HEYL, *Treasurer*, W. D. LAMBERT, *Recording Secretary*, H. E. MERWIN, *Member-at-Large, General Committee*, O. S. ADAMS.

At the conclusion of the business meeting, Mr. L. H. ADAMS presented an address entitled *What we know about the interior of the earth* (Illustrated by lantern slides). The outer parts of the earth have been thoroughly explored, at the surface and to a depth of a mile or so, but the sum total of our knowledge of the deeper parts of the earth is not very large. And yet the mysteries are slowly being solved. From varied sources information has been gathered and pieced together to form a picture of earth's interior—a picture as yet crude and imperfect but one which is gradually being made clearer and more complete.

Volcanoes bring up material from considerable depths and show us that beneath the cooler surface is a hot and active interior, the amount of radioactive substance found in ordinary rocks indicates that unless the earth is,-and always has been, growing hotter, the interior must be of a very different composition from that of the surface layers, geological studies have given us a store of information concerning the structure and composition of the rocks found at the surface and allow us to make certain deductions as to the way in which the character of the rocks should vary with depth, laboratory measurements on gravitational attraction tell us the density of the earth as a whole and indicate the presence of very dense material at the center; astronomical data on the motion of the earth give us the moment of inertia of the earth, from which the distribution of density in the interior can be inferred; and finally, the most important of all, the transmission of earthquake waves through the earth, taken in conjunction with laboratory measurements on the elasticity of rocks, yield very definite and conclusive evidence concerning the nature of the earth's material at various depths.

The present state of the earth is closely connected with the manner of its formation. It is generally agreed that the earth, as well as the other planets, were formed from the sun during the close approach of another star, which by tidal action pulled out large masses of glowing gas from the surface of the sun. One of these detached masses first liquefied and then solidified to form the earth. In the two billion years that have elapsed since its solidification, the temperature except in the outer few dozen miles has not changed appreciably. In the center of the earth is a core of iron, about 6000 km. in diameter, which settled out during the liquefaction. From the surface of the iron core upwards to the lower surface of the "crust" there is mainly ultrabasic rock (iron magnesium silicates) while the crust itself, 60 km. in thickness, consists of the ordinary granitic and gabbroic rock with a very small amount of sedimentary material at the surface. The rigidity of the earth, except near the center and near the surface, is everywhere greater than steel. The pressure increases steadily with depth and is about three million atmospheres at the center. The temperature in the very interior is unknown but is probably several thousand degrees. Further advances in our knowledge of the earth's interior will come mainly (1) from a higher precision in seismic data and (2) from a complete understanding of the physics of the atom so that the behavior of substances at all temperatures and pressures can be predicted. (*Author's abstract.*)

H. A. MARMER, *Recording Secretary.*

ENTOMOLOGICAL SOCIETY

379TH MEETING

The 379th regular meeting was held Thursday, December 3, 1925, in Room 43, National Museum, with President R. A. CUSHMAN in the chair and 25 members and 5 visitors present.

C. T. GREENE reported the death of Mr. H. W. WENZEL, Coleopterist, of Philadelphia. He was born in Philadelphia, May 16, 1858, and died there November 5, 1925, aged 67 years. A committee was appointed to draw up suitable resolutions

Election of officers followed: President, J. M. ALDRICH; 1st Vice-president, J. A. HYSLOP; 2nd Vice-president, J. E. GRAF; Editor, CARL HEINRICH; Corresponding Secretary-Treasurer, S. A. ROHWER; Recording Secretary, C T. GREENE; Executive Committee, W. R. WALTON, A. N. CAUDELL, T. E. SNYDER; Representative of the Society to the Washington Academy of Sciences, Dr. A. G. BÖVING.

Program: Dr. N. E. MCINDOO: 1. *Senses of the boll weevil.* (Illustrated.) 2. *An insect alfactometer.* This apparatus was on exhibition and its mechanism was explained to the society.

Mr. R. A. CUSHMAN told of rearing a species of *Sympiesis* as an external parasite of the eggs of *Cimbex americana* (Leach). The species of *Sympiesis* are normally parasitic on leaf-mining Lepidoptera and the speaker was of the opinion that the location of the host in this case was the determining factor leading to its parasitization by the *Sympiesis*

Dr. ALDRICH spoke of an interesting chapter in the history of Dipterology, giving an account of Meigen's visit to Kiel, Copenhagen, and Lund in 1824, at the expense and in the company of Wiedemann. This trip is described in Förster's biographical sketch of Meigen in Stettiner Ent. Zeitung for 1846.

Mr. J. L. WEBB made some remarks on the Thurbaria weevil, stating that it was considered a variety of the boll weevil.

Mr. K. W. BABCOCK spoke briefly, mentioning some of his experiences during a recent trip to Europe.

380TH MEETING

The 380th regular meeting was held Thursday, January 7, 1926, in the National Museum, with President J. M. ALDRICH in the chair and 25 members and 11 visitors present.

Report of the Corresponding Secretary-Treasurer for 1925 was read and accepted.

Dr. H. E. EWING, Chairman of the Committee which examined the Treasurer's books, reported the books correct. Mr. C. T. GREENE read his report as Recording Secretary for 1925. The reports were accepted.

Dr. O. A. JOHANNSEN of Cornell University was elected to membership.

Program. W. H. WHITE: *Plant resistance to insect injury.* Discussion by BACK, ROWHER, and BAKER.

AUSTIN H. CLARK: *Odors of male butterflies.* Discussion by BAKER, EWING ROHWER and SNODGRASS.

Mr. ROHWER exhibited a photograph of Dr. Walther Horn, of Germany, and his assistant, Miss Christel Doering.

Mr. J. A. HYSLOP spoke briefly to the Society on Mr. Chapman's book on insect equilibrium. Discussed by ALDRICH, BAKER, and SNODGRASS.

Mr. R. C. SHANNON exhibited several species of Syrphidae showing good examples of mimicry. This material was from the British Museum. He also spoke briefly about his forthcoming trip to Argentina.

E. A. BACK: *A Note on* Anthrenus seminiveus *Casey.* This Dermestid closely resembles the furniture beetle, *Anthrenus fasciatus.* The only reference to *seminiveus* is by Casey when he described the type, found in the building where he lived. After about 10 years two instances of destruction caused by this insect have been brought to the attention of the Department of Agriculture within a short time of each other during late 1925. In one case the brushes of a shoe-polishing outfit, in a hotel about half a mile from the building in which Colonel Casey lived, were ruined. In the other building in which Colonel Casey lived, a divan upholstered in curled hair, Spanish moss and tow, was found, on removing the cover, to harbor several thousand beetles and larvae. This is to be published shortly in the Proceedings of the Entomological Society of Washington by E. A. BACK and R. T. COTTON.

Mr. ROHWER recorded the occurrence of the European sawfly, *Acantholyda erythrocephala* (Linnaeus), in Pennsylvania. This European sawfly is a well known pest to European coniferous trees and two specimens were taken in a nursery at Chestnut Hill, Pa., May 7, 1925, by F. F. Smith and A. B. Wells. Both of these specimens were males.

Mr. ROHWER also recorded a second specimen of *Zadiprion townsendi* (Cockerell). This specimen was collected by W. J. Chamberlin, Santa Rita Mts., Arizona, July, 1924, and is the second specimen known. *Zadiprion* *townsendi* (Cockerell) was described in 1898 from a single female collected under a pine tree in the White Mountains of New Mexico. It is closely allied to *Zadiprion grandis* (Rohwer), an enemy to rock pine in Nebraska. Discussion by BAKER and EWING.

Dr. J. M. ALDRICH mentioned a case in nomenclature, where the name of a variety proved to be antedated by a name which also antedated the species. He asked whether in this case the variety becomes the species, or whether this relation is to be determined on taxonomic grounds without reference to priority.

381ST MEETING

The 381st meeting was held Thursday, February 4, 1926, in the National Museum with President J. M. ALDRICH in the chair and 29 members and 6 visitors present.

Program: R. A. CUSHMAN, retiring President: *Some types of parasitism among the Ichneumonidae.* (Illustrated by numerous lantern slides.) Discussion by Messrs. HOWARD, ALDRICH, BAKER, and GAHAN.

F. C. CRAIGHEAD. *Forest insects.* (Illustrated by numerous lantern slides showing the effect of the insect damage on the trees.)

382D MEETING

The 382d meeting was held at 8 p.m., March 4, 1926, in the National Museum, with President J. M. ALDRICH in the chair and 30 members and 15 visitors present.

Program VERNON L. KELLOGG: *Memories of a veteran entomologist, Dr. F. H. Snow.* Dr. Snow was born at Fitchburg, Mass., June 29, 1840, and died Sept. 20, 1908 He studied to be a Congregational minister. He was at the University of Kansas 42 years and was very much interested in zoology, botany and entomology. A great deal of teaching was done in the field and 26 or 28 major collections were made Dr. KELLOGG told interesting stories and incidents of some of these trips. He talked of the formation of the insect collection, and mentioned several of Dr. Snow's famous students.

Discussed by Dr. HOWARD, who spoke of W A. Snow, son of Dr. F. H. Snow.

Dr. WM. SCHAUS exhibited some books from the Dognin Library. These books were given to Dr SCHAUS personally for raising the money to buy the Dognin collection of Lepidoptera. These books were of the 17th and 18th centuries. Dr. SCHAUS spoke briefly of his impressions of the British Museum after an absence of 13 years

Dr. ALDRICH said that Dr. Williston sold his collection of Diptera to the University of Kansas in order to buy the H. H. Smith Collection of Diptera from the West Indies and Brazil. This latter collection was afterward sold to the American Museum of Natural History in New York City.

There was a general discussion on parasitism.

Mr. JACK BELLER of the Southern Museum of Los Angeles, California, spoke briefly to the Society.

Mr. J. E. GRAF exhibited specimens of the Mexican bean beetle showing some variations.

CHAS. T. GREENE, *Recording Secretary.*

383D MEETING

The 383d meeting was called to order at 8:10 p.m., Thursday, April 1, 1926, in the National Museum with first Vice-president Hyslop in the chair, and 18 members and 10 visitors present.

The Corresponding Secretary, Mr. Rohwer, read a circular letter from the International Institute for Intellectual Cooperation connected with the League of Nations requesting information on methods of distribution of technical publications in foreign countries. This matter was referred by the Society to the Corresponding Secretary, with power to act.

Dr. A. L. Melander, of the College of the City of New York, and Miss Grace Sandhouse of the Federal Horticultural Board, were elected to membership.

Program: W. A. Hoffman, of Johns Hopkins University: *Biological notes on Haitian Anophelines.* (Illustrated by lantern slides.) The two species of *Anopheles* known from Haiti, *A. grabhamii* and *A. albimanus*, were discussed, emphasis being placed upon the relations between the larvae of these species and their environment. *A. albimanus* in the main chose still water exposed to the sun, *A. grabhamii*, shaded streams. In some localities springs were of little importance as breeding areas of *A. albimanus*, while in other localities larvae abounded in them. The difference was ascribed to the different plant constituents present in the springs of these regions. Rice fields were carefully studied owing to the high incidence of malaria in coastal areas where this crop was grown. *A. grabhamii* seldom occurred in such situations. The two species reach their greatest abundance at different times, *A. albimanus* reaching its peak during the last third or quarter of the year, *A. grabhamii* as a rule in the period from January through March. Where favorable conditions obtain at all times great numbers of *A. albimanus* can be taken throughout the year. *A. albimanus* is believed to be the form chiefly responsible for the transmission of malaria. (*Author's abstract.*)

Asked in regard to food material Mr. Hoffman stated it to be blue green algae, *Spirogyra*, diatoms and plankton. Mr. Rohwer asked in regard to control, which was stated to be primarily cleaning out vegetation. Hyslop and Baker asked further questions in regard to control and Dr. S. F. Blake asked in regard to the deleterious effect of *Chara*.

Miss B. M. Broadbent. *Notes on the habits and development of the Azalea leaf miner,* Gracilaria Azaleella *Brants.* (Illustrated by lantern slides.) This species appears to be a native of Japan and first reached the United States prior to 1912 on azaleas imported from Holland. It has since become established in New York, New Jersey, Pennsylvania, Florida and the District of Columbia. An infestation of the azalea leaf miner at the U. S. War Department greenhouses in 1923 was brought to our attention and afforded an opportunity to study its habits and development. The moth deposits minute eggs singly close to the midrib on the ventral leaf surface which hatch about a week later. The larva immediately enters the leaf and feeds as a leaf miner for from ten to sixteen days, molting twice before cutting its way out and becoming a leaf roller. At first only the extreme tip is folded downward and attached to the midrib, but after each molt the larva cuts its way out and moves to a fresh leaf where it infolds and skeletonizes a greater area. The process of webmaking gives evidence of its remarkable industry. One larva while attaching leaf margins with webbing was observed to balance on its prolegs and sway to and fro 2367 times in one hour. For a period of 25 consecutive minutes it averaged 55 oscillations per minute or nearly one per second. As many as thirty strands may be attached between two points before changing position. By working from either side of the midrib the webbing is cross hatched, and shorter strands bring the surfaces in contact. The ends are filled with fan shaped webbing which is later snipped out to bring opposing edges in contact. Folded leaves are often cone-shaped. The larval period varied from 20 to 34 days during April, whereas the previous generation had required about 55 days.

When ready to pupate the larva attaches strands of webbing across each end of the slightly rolled edge of the ventral leaf surface, filling in the central area last. Before emergence it forces itself half way out of its cocoon so that the moth leaves the exuvia projecting from it. The pupal period varied from 7 to 16 days. The sexes appeared in about equal numbers. One female deposited 40 eggs. Longevity varied from 1 to 9 days. (*Author's abstract.*)

Messrs. SIMMONS and SCHAUS discussed the emergence of the pupa from the cocoon. Dr. ELY stated that a native species of *Gracilaria* in Connecticut on swamp azalea is badly parasitized. Mr. ROHWER and Dr. WEIGEL stated that in the introduced species there were no parasites. The out-door distribution of the species was given as New York, Pennsylvania, Connecticut and Florida. Dr. CORY of Maryland found similar work on azalea in breeding beds.

Under notes and exhibition of specimens Dr. BÖVING showed a plate with habitus figures and anatomical details of the larva of the flea beetle *Oedionychis gibbitarsa* (Say). He described a few of the characteristic structures of the larva, especially the maxillary mala. The latter is apparently single, but consists (as a comparison with other Chrysomelid larvae proves) in reality of a well developed galea and a large lacinia that is situated behind galea and completely fused with it. The galea carries a two-jointed peg and irregularly distributed setae, the lacinia is armed with a longitudinal series of long stiff setae. The remarkable bilobed mala in the *Donaciinae*, strongly adapted for sapsucking purposes, is a further development of the morphologically simpler structures in the *Halticinae* and other Chrysomelid larvae, combined with the presence of a long stylus from the end of lacinia as it occurs in several Coleopterous larvae, for instance, in many *Ptinoid* larvae but not in the *Halticinae*.

Dr. HOFFMAN inquired in regard to the food habit of *Blephridae*. Mr. BARBER stated that it was sumac.

SPECIAL MEETING

On April 20 a special meeting of the Entomological Society was held at which Vice-president, J. E. GRAF, called the meeting to order and requested Dr. HOWARD to preside. Dr. HOWARD in introducing the speaker, Dr. R. J. TILLYARD of Cawthron Institute, Nelson, New Zealand, stated that this was only the third time a special meeting had been called to honor distinguished foreign visitors. Dr. TILLYARD talked on the fossil insects in the more important and larger orders and showed some excellent pictures of the fossils, which were of great interest to systematists of the Bureau of Entomology. Some of the prototypes of present families and groups were of particular interest, especially in the case of the roaches and beetles, there being some slight indication of a common ancestor of these two groups as well as a common ancestor between the roaches and termites.

384TH MEETING

The 384th meeting was held on May 6, 1926, in the National Museum. It was called to order by the Corresponding Secretary, Mr S. A. ROHWER, who in the absence of other officers, requested Mr. A. B GAHAN, a past president, to preside. There were present 13 members and 12 visitors.

Program: Dr. W. J. NOLAN: *Sex forms of honeybees.* (Illustrated.) Although some knowledge of parthenogenesis in the honeybee is credited to Aristotle, a scientific basis as to the sexes found in the honeybee was not forthcoming until Swammerdam in the latter part of the seventeenth century established the sex of the queen. Before that time many curious ideas existed as to the three castes, and the method of reproduction in a colony. Some even held that the honeybee arose by spontaneous generation from decaying flesh. In the latter part of the eighteenth century, over one hundred years after Swammerdam's discovery, Huber, the blind Swiss investigator, made known the fact that the queen mates on the wing outside the hive. In Germany shortly before this time, Riemer had established, or re-established if Aristotle is kept in mind, the fact that in a queenless colony certain of the workers may begin to lay, but that their eggs will develop only into drones. Not long after this, Schirach had found that a colony deprived of its queen, but possessing worker larvae not too old, can rear another queen from one of the worker larvae. It remained for Dzierzon, in 1842, after empirical evidence from mating experiments on two differently colored races, the Italian and German brown, to set forth the theory that workers and queens arise from fertilized, and drones from unfertilized eggs. Neither the findings of Dzierzon, nor any of the other men mentioned, remained unchallenged. It was not until the 20th century, following a series of cytological investigations culminating in the work of Nachtsheim, that Dzierzon's opponents were routed. One in particular, Dickel, had maintained that all eggs are fertilized, but that the workers by use of a salivary secretion determine which are to develop as males and which as females. Nachtsheim in his paper of 1913 found no evidence of fertilization in eggs from drone cells, but abundant evidence in eggs from worker cells. Furthermore he confirmed the reports of earlier investigators that the germ cells of the drone at all times contain only the haploid number (16) of chromosomes, while the fertilized eggs, from which only females develop, have the diploid number (32). Onions in South Africa in 1909, and again in 1912, announced to a rather skeptical world, that the worker of the South African honeybee, as contrasted with that of the European honeybee, could rear workers and queens parthenogenetically. This work was confirmed in 1916 by Jack, Entomologist for South Rhodesia. Further work on this subject is now reported in progress, especially on the cytological side. It should be noted that the African races of honeybees, as a group, have sufficient distinct characteristics from the European races, as a group, to have led Von Buttel-Reepen to classify them as distinct subspecies.

That a queen can be reared from any worker larva, given the proper food and attention, although the basic principle in the extensive queen-rearing business of the present time, has never been adequately explained. Doctors Becker and Zander in Germany last year gave the results of their endeavors to get intermediate forms between worker and queen by taking unsealed worker larvae of all ages and transferring them to queen-cells by the method commonly employed in queen-rearing. They found that only larvae not more than three and one-half to four days old would develop into queenbees. After this narrow time boundary physical modifications typical of workerbees are too far advanced, whereas the development of the reproductive organs is so arrested that larvae in worker cells are no longer capable of becoming queenbees. The first introduction of pollen in the food of the worker larva seems to mark the end of the time when it can develop into a queenbee. The exact factors involved in this arrested development of the reproductive system, however, remain to be cleared up. (*Author's abstract.*)

Mr. Rohwer in commenting on Dr. Nolan's talk stated that a new species of *Apis* has been discovered in Australia. He also stated that students in Europe had discovered a parthenogenetic and fertile stage in the sweat-bee, *Halyctus*, and probably this would have some effect on the deduction in the theories in regard to the life of the social bees. Mr. Rohwer further inquired concerning subspecies and Dr. Nolan stated that they are usually referred to as races or varieties, but Von Buttel-Reepen referred to them as subspecies. Dr. Snyder asked in regard to the progeny of the egg-laying workers and Dr. Nolan stated that they were all drones but that the spermatheca is slightly larger. Dr. Snyder also referred to Miss C. B. Thompson's work begun with Dr. Gates of Massachusetts Agricultural College on morphological, cytological and experimental work on the worker and queen in the honeybee to determine whether there were marked differences in the brain, sex organs, etc., in these two castes and whether the "royal jelly" fed to the three day old worker really changed it to a queen or whether there was not some inherent cause, such as there is in termites and ants in the origin of caste.

Dr. T. E. Snyder: *Insects change building code.* (Illustrated.) Owing to lack of information on the destructiveness of our 42 species of native termites, buildings are often erected improperly. In consequence termites greatly damage the woodwork of the buildings. It is a great hardship for small householders to make expensive repairs before the building has been paid for. Such damage is serious in the Southern States, the Central West and Pacific Coast. The only effective permanent preventive is proper construction of buildings and insulation of all untreated woodwork from contact with the ground. Slight changes in city building codes have been suggested to city engineers throughout the United States and with the help of the National Utilization Commission it is believed that ant-proofing buildings by modification of building codes will be possible. Many large government buildings in Washington have been damaged by termites, but active cooperation has been affected with the Superintendent of Buildings and Grounds to prevent such damage in the future. As object lessons, model demonstration termite-proof buildings are being erected in the Canal Zone, Panama, and at New Orleans, La. In addition to complete insulation of all untreated wood from the ground by the use of concrete foundations or timbers treated with coal tar creosote against subterranean termites, not more than 10 per cent of lime mortar should be used for making cement or brick foundations, since termites penetrate lime mortar. Together with these precautions in regions where nonsubterranean termites are a serious menace all interior wood-work and furniture must be impregnated with zinc chloride or sodium fluoride. (*Author's abstract.*)

Mr. Rohwer asked if there would not have to be different building code changes for the subterranean and non-subterranean termites. Dr. Snyder stated that this was the case. Mr. Wood discussed damage to nursery stock, potatoes and the woodwork of buildings in Kansas. Mr. Gahan asked in regard to termite damage to structure in rural regions and Dr. SNYDER stated that very often farmers use tin termite guards between the foundations and upper woodwork. Mr. SIMMONS asked in regard to the method of impregnating wood with sodium fluoride. Dr. SNYDER stated it to be by the "open tank" method and gave details.

The Corresponding Secretary, Mr. ROHWER, called upon Mr. O. MORLAND, of England, to say something about honeybees He stated that Isle of Wight disease due to an Acarine parasite was believed to be absent from the United States and that this was probably true since the method of dissection was the same in the United States as in England. He had reached these conclusions after a conference with Dr. Sturtevant. Mr. MORLAND further stated that exclusion of bees from countries where this disease occurred was wise. Mr. GAHAN thanked Mr. MORLAND for his kind words about the federal quarantine laws in the United States which are so generally being criticized at present.

Mr. MORRISON discussed a recent paper on hermaphrodism in scale insects and stated that if this work proved true it would have wide application and it might be found to apply in other groups of insects.

385TH MEETING

The 385th meeting was called to order at 8 p.m., on June 3, 1926, in the National Museum by Vice-president J. HYSLOP.

PERCY VIOSCA, Jr., of New Orleans, La , who was to have been the first speaker was unable to appear.

Program: J. A. HYSLOP: *The Bureau of Entomology's exhibit at the Sesquicentennial exhibition at Philadelphia.* (Illustrated.) In addition to exhibiting the lantern slides prepared by various branches of the Bureau, maps were shown of the exposition grounds showing where the exhibits would be housed.

Mr. P. SIMMONS gave a talk on the history of carbon bisulphide as a fumigant and the discovery of its fumigating properties. Credit for the discovery of the insecticidal property of carbon disulphide has generally been accorded to Louis-Michel-Francois Doyère. However, the evidence shows that, although Doyère made the discovery independently, his work was anticipated by Dr. Lazare Garreau, who published his results in 1854. Doyère's account of his discovery appeared in 1857, following experiments carried on at Algiers. Both investigators first used the method for the control of insects infesting stored grain. For this purpose, and for the control of certain insects living in the soil, carbon disulphide still remains our chief reliance after a lapse of about 70 years. Doyère (1811–1863) was a teacher of zoology and natural history. He was much interested in the conservation of grain, and published on milk, ensilage, and economic entomology. Garreau (1812–1892) started as a military pharmacist, in which capacity he served several years in Algiers. From 1844 until his retirement in 1886, he was a teacher of medical chemistry, toxicology, and related subjects in various institutions in the city of Lille. Among his publications on a number of subjects, some of the most important dealt with the respiration of plants.

Mr. A. B. GAHAN recorded the death of Dr. H. S. SKINNER, who had long been connected with the Academy of Natural Sciences, Philadelphia, and was for many years editor of Entomological News. It was moved by the Society that an obituary committee be appointed and Vice-president Hyslop announced that this committee would be named later.

Mr. **Gahan** exhibited a drawing of a Chalcid egg parasite in Cicada eggs from Meyers of New Zealand. The peculiar arrangement of the ovipositor in a sac folded under the body was illustrated in this peculiar new genus.

Mr. C. L. **Lankan** exhibited specimens of insects found in flower pots. Mr **Barber** determined them as small *Collembola*.

Mr. **Wood** stated that in a shipment of passenger's baggage were hampers full of sparta grass used in making paper, and that 9 species of insects including Chrysomelid beetles and jointworms were found hibernating in the grass.

Dr. **Snyder** gave a short note on the amoebae and spirochaetes recently found living in the intestines of termites by various workers and stated that since the aborigines or natives of some tropical countries ate termites alive possibly there was a relation between these forms of life in the termites and pathogenic forms in man. It was stated that very little was known of these spirochaetes but that in the history of human disease caused by these organisms there may have been a relationship in the past.

Mr. **Gahan** stated that he had received a letter from Mr. James Waterston of the British Museum containing the statement that what purported to be the Motschulsky Collection of Hymenoptera had been discovered in an attic room of Moscow University at Moscow. If true, this would make it possible to fix the identity of a number of genera and species which are now in doubt. Much interest was evidenced in this reported location of the Motschulsky collection, Mr. **Barber** discussing his collection of Coleoptera and other members his work in other orders

Thos. E. Snyder, *Recording Secretary pro tem.*

386TH MEETING

The 386th meeting was called to order at 8 p m., October 7, 1926, in the National Museum, with President **Aldrich**, in the chair and 24 members and 12 visitors present.

Attention was called to the fact that the committee on the obituary notice of Dr. **Henry Skinner** had taken no action so far.

Mr. **Rohwer** stated that it seemed likely that there would be a vacancy in some of the offices of the Society, especially that of the editor, before the next regular election, and moved that the executive committee be empowered to fill any vacancies that may occur before the next annual election. The motion was carried.

Program: J. M. **Aldrich**: *Collecting Diptera in Guatemala.* The speaker spent April and May in Guatemala, paying especial attention to the collection of muscoid flies. While there he traversed the railroads from Puerto Barrios to the Mexican border at Ayutla and also visited the Pacific Coast at San José. April being in the end of the dry season the collecting was not very good. In May, at the special request of the Minister of Agriculture at Guatemala he accompanied a government party to Cobán for the purpose of assisting in investigations of the migratory locust and its parasities. Cobán being considerably off the railroad it was necessary to ride a mule about 100 miles to reach it. The return trip was made by a different route coming out by the Polochic River, Lake Isabel and Livingston. The amount of material collected was considerably less than expected, but some progress was made in the study of the parasites of the locust, and other interesting results were obtained.

C. T. **Greene**: *Collecting fruit flies in Panama.* A brief outline of the localities collected in while in Panama from March 14 to May 27, 1926 was given, and an idea of the breeding methods used. The speaker reported the capture of a rare Tachinid fly *Bibiomima Handlirschii* B. B. at Ancon, C. Z., April 7, 1926. This is the first North American record and the second specimen known.

Dr. **STEPAN SOUDEK** told how much he appreciated the help given him by various people while in America. He said he had gained much valuable knowledge regarding the insects.

Mr. A. F. **BURGESS** of Melrose Highlands, Mass., mentioned some points in the work being done by Brown, Meusebeck, and Webber on parasites of the gipsy moth.

Dr. J. B. **PARKER**: *Vespula* (*Dolichovespula*) *diabolica* (Saussure). On August 1 of this year the superintendent of the grounds at the Catholic University of America, Brookland, D. C., reported that he had found a nest of "yellow hornets," which were later identified by Mr. **ROHWER** as *Vespula* (*Dolichovespula*) *diabolica* (Saussure). Twice before a nest of "yellow hornets," presumably this same species, had been found on the University grounds and been burned before the speaker was aware of what was going forward, and it was at his request that this one was reported to him instead of being destroyed at once. In every case the nest had been placed on an evergreen tree and no nest had been over six feet from the ground In order that the identity of the species might be determined, a single specimen was captured on August 7 as it was leaving the nest. This specimen proved to be a young queen On the next day the nest was damaged in a storm by being dashed against a broken branch on a neighboring limb of the tree on which the nest was built. The wasps repaired this damage to the side of the nest and in order to guard against any further damage from this source the speaker removed the broken limb. The nest was secure until August 21, but when next visited, on the 24th, it was found to be completely destroyed. A small part of the nest and some of the comb still remained attached to the branch on which the nest was built and the rest was scattered about on the ground. Everything indicated that the destruction had been the work of mischievous boys. In a piece of the comb were found two fully developed males just ready to emerge when the nest was destroyed. These were mounted so that in the collection of the Museum are two males and one female of this species taken from the same nest. Aside from these two males, the combs were empty, neither larvae nor pupae being present. The nest had been destroyed a day or two before the speaker discovered the fact, so that what evidence was obtained indicates that this species rears its males and young queens in early August. The nest, so far as can be judged from its appearance while on the tree, does not differ from that of the whitefaced hornet (*Vespa maculata*). What differences, if any, might be found by taking the nests of the two species apart and comparing their structure are not known. It is to be hoped that another nest of these yellow wasps will be found and that observations may be carried on under less discouraging conditions.

Dr. M. C. **HALL** gave a brief outline of his recent trip to Central America. He was especially interested in animal parasites.

387TH MEETING

The 387th meeting was called to order at 8 p.m., November 4, 1926, in the National Museum, with President **ALDRICH** in the chair.

Messrs. **HYSLOP**, **CUSHMAN** and **SCHAUS** were appointed as a committee to draw up resolutions on the death of Doctor **HENRY SKINNER**.

At the suggestion of Mr Rohwer the Corresponding Secretary was instructed to send appropriate greetings to the Entomological Society of Hungary to be read at the commemorative meeting held to celebrate the 80th birthday of Dr. Geza Horvath to be held on November 23, 1926.

Program: H. E. Ewing: *Recent developments in regard to the control of chiggers.* All the states in the life history of the chigger have been obtained but the egg stage. We are not sure that an egg stage exists, but in all other species of the family to which the chiggers belong, as far as life histories are known, eggs are laid. At the Summer Boy Scout Camp, located on Chesapeake Bay, the following control measures proved effective. sulphuring of the badly infested spots, including several of the paths, the cleaning up of all dead leaves and other litter near the tents, the protection against chiggers by applying sulphur to the skin and clothing. The common box turtle proved to be the most important natural host. Turtles of this species are being removed and in their place the camp ground is being stocked with the painted turtle, mud turtle, spotted turtle, and musk turtle, none of which carry chiggers

Discussion by Messrs Gahan, Aldrich, Snodgrass, and Rohwer.

Dr W. H Larrimer spoke briefly on the practical nature of the corn-borer problem Discussion by Messrs. Hyslop, Rohwer, Cushman

The Society congratulated Dr and Mrs. W. M. Mann on their marriage.

Dr. A. G Böving gave a general characterization of the larvae of the *Eumolpinae*, discussed their relationship to the larvae of the other Chrysomelid subfamilies, mentioned that the genera and especially the species of the *Eumolpinae* are very insufficiently represented in the National Museum by their immature stages, and concluded with the following comments on the characters by which some of the species could be recognized: The larvae of *Chrysochus auratus* (Fab) has projecting parasternal lobes on the abdomen, suggesting hairy prolegs, each anal lobe carries a single chitinous plate, the mandible terminates with three teeth, and there is one ocellus on each side of the head. An unknown species from Tennessee, feeding on the roots of broom-sedge and weeds, is very similar to *Chrysochus auratus*, but has two circular plates on each anal lobe, the mandible terminates with two teeth and there are three minute ocelli on each side. The larva of *Paria canella* (Fab) has distinct and hairy, but not projecting, parasternal lobes, the anal lobes are without any chitinization, the ninth abdominal tergite is posteriorly equipped with four chitinous, rounded tubercles and the mandible has two terminal teeth close together plus one lateral tooth. In the larva of *Typophorus viridicyaneus* (Cr.), from the roots of sweet potatoes, the mandible carries two terminal teeth plus one lateral tooth as in *Paria canella*, and it is also similar to this species in all other structural characters except in that the ninth abdominal tergite has no chitinous posterior tubercles. *Graphops pubescens* (Melsh), *Fidia viticida* Walsh, *Colaspis costipennis* Cr and *Colaspis flavida* Say are very close to *Typophorus viridicyaneus*, but they can be distinguished from this species by the single character that they all possess, a mandible in which two terminal teeth are more or less united and a lateral tooth is lacking. From each other they can not be separated by any structural difference

Mr. J. A. Hyslop read a letter and a portion of a manuscript from Dr. G. N. Wolcott of Porto Rico on the flight of the butterflies at Port-au-Prince, Haiti.

Dr. J. M. Aldrich spoke briefly on the gatherings of the entomologists at Pingree Park, Colorado He exhibited a copy of the "Report of the 4th Rocky Mountain Conference of Entomologists at Pingree Park, Colorado, August 16–21, 1926." Containing a list of those present, notes on the meeting, and a list of officers for 1927.

Mr. **Rohwer** exhibited "Insects of Western North America," by Prof. E. O. **Essig** and commented on the book as containing much new biological information concerning the species, a fairly satisfactory classification, an extensive bibliography, and many original illustrations Mr **Rohwer** believed that this was one of the best books on insects which has been issued recently, and contained more names of insects than any other book of its size.

Dr. T. E. **Snyder** spoke briefly on the parasites of termites.

Mr. C. T. **Greene** reported the finding of larvae of *Rhagoletis pomanella* Walsh in prunes from North Chatham, New York, October 5, 1926. The material was received from Dr. E. P. **Felt**.

Chas. T. Greene, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

The National Academy of Sciences will meet in Washington April 25, 26, and 27, in the National Research Council building. On Monday night, April 25 there will be a popular science lecture for the public.

The American Geophysical Union will meet April 28 and 29 in the national Research Council building. On the evening of the 28th there will be a lecture for the public on climatic factors.

The remainder of the botanical collections of Captain **John Donnell Smith**, presented to the Smithsonian Institution in 1905, were recently received by the National Herbarium. The total number of the John Donnell Smith Herbarium is well above 100,000. It is especially rich in Central American plants and contains the types of the numerous species described by Captain **Donnell Smith**. The collection was mounted and in excellent condition. It is now accessible for study at the National Herbarium.

The Botanical Society of Washington held a special meeting March 15 in room 43 of the New National Museum. Dr. C. C **Plitt**, of the School of Pharmacy, University of Maryland, gave an illustrated talk on the distribution and succession of lichens. Dr. E. W. **Berry**, of Johns Hopkins University, discussed early forms of vascular plants, especially those of the Devonian formation, with lantern slides showing restorations. Dr. **Burton E. Livingston**, of Johns Hopkins University, showed a device for measuring available water-supply in surface soil. It consists of a small subcylindrical cone of porcelain, the tip and upper part impervious to water, and with a porous zone about 1 cm. wide. Investigations were carried on in a lawn of the University by means of these mechanical root-tips. Dr **Duncan S. Johnson**, of Johns Hopkins University, gave an illustrated talk on the revegetation of a valley in Jamaica which had been denuded by a landslide following unusually heavy rains seventeen years ago.

The Elk Commission, called by the Secretary of War as chairman of the President's Conference on Outdoor Recreation, held a meeting in Washington from February 28 to March 3, to consider the problem of preventing the starvation of the southern Yellowstone herd of elk in bad winters in the region of Jackson Hole, Wyoming. The history of this herd shows that hard winters following a period of favorable years reduces the herd so seriously as to threaten their extermination. A plan of administration was decided upon for the preservation of this, the largest herd of elk in existence. Not more than

20,000 elk are to be maintained. The present winter range will not support this number in unusually hard winters, so it was recommended that the Federal Government acquire certain private lands, which, being added to the existing Federal game refuge and the adjacent property of the Izaak Walton League, would provide feed to carry the elk through the bad winters. An immediate count of the elk was recommended, the plans to be developed by the supervisor of the Teton National Forest, the game warden of the Biological Survey at Jackson Hole, and a representative of the Wyoming State Game and Fish Commission. It was proposed that the Biological Survey make a study of the life history of the elk and of conditions bearing upon their maintenance in suitable numbers. It was recommended that the Wyoming Game and Fish Commission be given wide latitude in handling such problems as length of hunting seasons, bag limits, and the establishment of hunting areas, and also authority to remove by official killing and disposal for economic use any surplus that might remain after hunting. E. A. GOLDMAN and T. S. PALMER, of the Biological Survey, WILL C. BARNES, of the Forest Service, are members of the Commission.

J. E. SPURR, Editor of the Engineering and Mining Journal, and formerly a member of the United States Geological Survey, addressed the Petrologists' Club in the Director's room at the Geological Survey March 14, on *Ore magmas and vein dikes.*

Professor JOHANNES WALTHER of the University of Halle, Speyer Visiting Professor at Johns Hopkins University, spoke to the Pick and Hammer Club on March 19 on *The formation of red beds in the deserts of Western Australia.*

E. O. ULRICH, G. R. MANSFIELD, H. D. MISER, L. W. STEPHENSON, C. H. DANE, PARKINSON POPENOE, W. T. THOM, JR., and C. E. DOBBIN of the United States Geological Survey attended the meeting of the American Association of Petroleum Geologists at Tulsa, Oklahoma, March 24–26. Mr. ULRICH and Mr. DOBBIN read papers.

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PHYSICS.—*Some mechanical properties of moist granular solids.*[1]

P. G. Nutting, U. S. Geological Survey.

The striking mechanical properties of moldings and and of certain silts, clays and soils containing various amounts of water are well known and have long been a source of utility and interest. Compacted molding sand retains its form and dimensions under rather severe mechanical and heat treatment. Wet silts and clays dry out leaving a rather hard cake but coarser sands do not unless they contain at least a small fraction of the finer material. The finer clays not only cake on drying but with considerable shrinkage, reversible with the moisture content. The problem under consideration is the underlying cause of these peculiar properties of granular solids.

Such properties have been attributed to a colloidal fraction possessing unique properties and composition. When separated from the mass, however, usually by churning and settling in water, these "colloids" were found not to differ greatly in composition from the coarser particles with which they were associated.[2] In other words, the "colloids" are nothing but extremely fine particles of the same material—silica and silicates in the case of silt and clay. The question might easily be settled by direct observation but for the fact that colloidal properties begin to be shown by particles just too fine to be observable (in detail) with a microscope, namely at diameters just less than the length of a light wave ($\frac{1}{2}$ micron). Particles about 5×10^{-6} centimeters in diameter exhibit the most striking colloidal properties. This is about 100 molecular diameters and roughly $\frac{1}{10}$ the limit of the microscope.

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[1] Published by permission of the Director, U S. Geological Survey Received March 1, 1927.

[2] U. S Bureau of Soils, Bull 1193, 1311, and 1452. A V. Bleininger, 2nd Colloid Symposium Monograph 90.

The physical problem is that of finding the mechanical effect of a varying moisture content on an aggregate of solid mineral particles of a given size and size range and of a given shape. Surface tension, vapor tension, atmospheric pressure and internal (adsorption) pressure are the forces involved in causing the observed cohesion and resistance to deformation.

It is well known that silica, alumina, most silicates and many metals absorb a film of water from 50 to 100 or more molecules deep under ordinary atmospheric conditions and part with it with great reluctance when desiccated or heated. This film represents 20 to 25 per cent by weight in finely divided or porous materials such as bentonite or silica gel and about $1 \frac{\text{milligram}}{\text{gram}}$ even in ordinary sand. 100 molecules of water, at $4 \times 10^{-8} \frac{\text{centimeter}}{\text{molecule}}$, is 4×10^{-6} centimeters in film thickness. The adsorptive force between the silica and the water in contact with it is about 17000 atmospheres and decreases almost linearly with the depth of the film. The depth of the adsorbed film represents equilibrium between external fluid or vapor pressure and internal adsorption pressure.

When the quartz grains are in contact, their adsorbed water films would be expected to merge out to where the separation is at least twice the depth of film, or say 8×10^{-6} centimeters. If contact is over an area A having a mean diameter $2r$, then the edge of the film would be pulled outward with a (negative) pressure of about 18 atmospheres. The two grains in contact would therefore be drawn together with a pressure of that magnitude or a force of $18A \times 10^6$ dynes. If the contact averaged say 0.01 mm. across, then the force would be 18 dynes or about 0.018 gram weight.

Thus, in an aggregate of particles, the cohesive pressure may mount to a respectable figure, depending largely upon the size and shape of the grains. The so-called adsorption of solids by solids may be in many cases merely the result of intervening films of adsorbed water. Any one who has sought to free coarse sand grains from others below 300 mesh, knows how difficult it is without resort to water immersion. This destroys the tension and restores the adsorbed film to its maximum thickness. A more detailed theoretical treatment of the practical problem dealing with irregular grains would lead at once to complex probability functions. It may be noted however that the cohesional force increases with the amount of water present up to a maximum and then falls off to zero with complete wetting. Footprints are not made in sand or silt either dry or under water but in material partly dry.

The simple problem of wetted solid spheres in contact is easily treated and throws light on some mechanical effects. Let spheres of radius R be in contact and let the contact region be filled with water to a distance r from the axis of contact. Let

$$\mathrm{Sin}\theta = \frac{r}{R}$$

The radial tension on the water film is $2\tau\mathrm{Cos}\theta \times 0.2\pi r$ where τ is surface tension. The area over which this acts is $4\pi r(R - R\ \mathrm{Cos}\theta)$, hence the radial tension (force per unit area) is

$$P = \frac{F}{A} = \frac{\tau}{R}\frac{\mathrm{Cos}\theta}{1 - \mathrm{Cos}\theta} \tag{1}$$

The force pulling the spheres together is pressure × area or $\pi r^2 p$ plus the direct tension $2\pi r\tau$ at the edge of the film or

$$\begin{aligned} F &= \pi r^2 P + 2\pi r\tau \\ &= \pi R\tau[\mathrm{Cos}\theta(1 + \mathrm{Cos}\theta) + 2\mathrm{Sin}\theta] \end{aligned} \tag{2}$$

The maximum value of the parenthesis is 2.60 for $\frac{r}{R} = \mathrm{Sin}\theta = 0.755$ or $\theta =$ about 49°. For both $\theta = 0$ and $\theta = 90°$, $F = 2\pi R\tau$ which is about $\frac{3}{4}$ of its maximum value. When the voids in a mass of grains are entirely empty or filled with water cohesional forces drop to zero and a lump of material "melts."

According to (2), the force acting between individual particles varies directly as their radius R if the proportional amount of wetting $\left(\frac{r}{R}\right)$ remains constant. But the number of particles per unit area varies inversely as their cross section or as $\frac{1}{R^2}$, hence the cohesional force per unit area varies inversely as the diameter of the particles. Further, the number of layers in a unit cube varies also inversely as R, hence the aggregate cohesional force in a unit cube (pressure gradient) varies inversely as the *square* of the linear dimensions of the component particles.

Some numerical examples may be of interest. Taking the angular fill $\theta = 49°$ and the surface tension of water $\tau = 72\ \frac{\text{dynes}}{\text{centimeter}}$, $F = 590\ R$ dynes. In Table 1 are given calculated values of F for $R = 0.01$, 0.0001 and 10^{-6} centimeters or $R = 100$, 1 and 0.01 microns, the range between fine sand and clay. One atmosphere $= 1033200\ \frac{\text{dynes}}{\text{centimeter}^2}$. A drying silt or clay is subjected to internal cohesive pressure of these orders of magnitude and thereby acquires considerable rigidity of form. The above theory indicates further that this internal pressure is nearly independent of the water content over a wide range. The finer clays are known to retain several per cent of water when heated even to 600–800°C, hence bonding by sintering and incipient fusion is likely to occur before a clay is released from internal pressure due to water.

The cohesive pressures and pressure gradients deduced above are evidenced by many known facts and direct tests. Molding sand must be fairly fine and will not function when too dry or too moist nor when greasy. Experiments by the writer on powdered quartz 0.05 to 50 microns in diameter and on glacial silt (from granite) 5 to 50 microns in diameter, show the phenomena of cohesion very nicely. The finer sizes alone show shrinkage on drying and swelling on wetting with water. In turpentine or other liquid which is but feebly adsorbed, the finer material behaves like coarse sand in water. In determining the densities of fine grains with a pycnometer, turpentine is used to avoid errors due adsorption of water. Powdered quartz under 0.2 micron in diameter, when suspended in water, exhibits the peculiar stratification so familiar in the case of bentonite in suspension. The finest quartz particles never settle but in a week or two hydrate to silicic acid and go into dialyzable solution.

TABLE 1.—VALUES OF F

GRAIN RADIUS	COHESIVE FORCE BETWEEN GRAINS	COHESIVE PRESSURE	PRESSURE GRADIENT
100 microns	5.90 dynes	0.015 atmospheres	0.75 $\frac{\text{atmospheres}}{\text{centimeter}}$
1 "	0.059 "	150 "	7500 "
0.01 "	0.00059 "	15000 "	7.5×10^6 "

The volume of water in a film of radius r contained between two spheres of radius R is twice the integral from 0 to r of $2\pi r R r(1 - \operatorname{Cos}\theta)dr$, or

$$(3) \qquad \text{Water volume} = 2\pi r^2 R - \frac{4}{3}\pi R^3(1 - \operatorname{Cos}^3\theta)$$

from which the percentage of water may be readily computed for any particular case, the total volume (relative) being that of the circumscribed cylinder or $2\pi r^2 R$.

An aggregate of fine and coarse particles together, when moist takes on the properties of the finer particles alone since each large particle has high cohesion and rigidity within itself. The fine particles act simply as cementing material. The proportion of fines need be only very small since their cementing function is limited to the very small volume in the immediate neighborhood of points of contact between larger particles.

In a pile of sand or spheres in loosest packing (6 contacts), roughly half the volume is void. In closest packing (12 contacts) about ¼ is void. Other things being equal therefore, with a given size of particle and given moisture content, packing will considerably increase the cohesion in a mass of particles by increasing the number of contacts. The effect of packing on molding sand may be due largely to such a cause.

The relation between pressure (external and internal) and the specific volume or density of a granular solid or mass of solid grains is of considerable practical and geologic interest. A granular mass differs from a solid in being capable of indefinite shear and from a fluid in possessing a finite shear limit. The internal pressures deduced above for very fine particles moistened, are of the same order of magnitude as those derived by T. W. Richards[3] for numerous elements in the solid and liquid states. A formula similar in form to van der Waals' equation of state might be expected to serve, the $v - b$ of his equation being translated into pore space and the term $\frac{a}{v^2}$ into internal cohesive pressures since we are dealing with grains instead of molecules. Data for determining constants for granular masses under load are very meager but some relations between porosity and depth in deep well cores give a rough check with this formula or a still simpler one. The various relations between specific volume and related quantities are given below.

$$\text{Porosity} \quad P = \frac{\text{fluid volume}}{\text{total volume}} \qquad P = \frac{L}{V}$$

$$\text{Void Ratio} \quad R = \frac{\text{fluid volume}}{\text{solid volume}} \qquad R = \frac{L}{S}$$

$$\text{Solidity} \quad M = \frac{\text{solid volume}}{\text{total volume}} \qquad M = \frac{S}{V}$$

$$\text{Density} \quad D = \frac{\text{mass}}{\text{volume}} = \frac{1}{\text{specific volume}}$$

$$D_g = \text{grain density} = \frac{\text{mass of grains}}{\text{volume of grains}}$$

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[3] Journ. Am Chem. Soc. 48: 3063–3080. 1926. Also previous papers.

From these defining equations it follows that

$$PV = RS = L$$

$$P = RM = 1 - \frac{D}{D_0} = \frac{R}{1+R}$$

$$\frac{1}{P} = 1 + \frac{1}{R}$$

$$R = \frac{P}{1-P}$$

$$(1 - P)(1 + R) = 1$$

$$1 + R = \frac{V}{S} = \frac{1}{M}$$

$$M = 1 - P$$

$$\frac{D_2}{D_1} = \frac{M_2}{M_1} = \frac{V_1}{V_2} = \frac{1 - P_2}{1 - P_1} = \frac{1 + R_1}{1 + R_2}$$

The term $v - b$ of van der Waals' equation becomes $V - S = L$ in the above notation, hence since S is constant, the modified equation is

$$(p + p_c)R = \text{constant.}$$

For practical work on sedimentation as a function of time t and load, the writer has found useful the simple dynamic formula

$$\log(V_0 - V_\infty) - \log(V - V_\infty) = C_1 t + C_2(p + p_c)$$

in which V_0 and V_∞ are initial and minimum specific volumes and C_1 and C_2 are constants.

When an aggregate of particles is completely immersed in water, surface tension effects are absent but the adsorbed layer of water remains intact. In this layer the maximum pressure is known to be at least 15000 atmospheres, which according to Bridgman is sufficient to compress water about $\frac{1}{4}$. Hence the densities of fine particles, determined by the pycnometer method, are apparently higher when water is used than when a much less strongly adsorbed liquid such as benzol or turpentine is used. Both absorption pressure and heat of wetting are much lower for liquids of high molecular weight and large molecular diameter than for liquids having the opposite properties.

The condensed adsorbed films on fine siliceous particles immersed in water should show a slight surface tension toward the adjacent uncondensed water tending to draw the particles together. Such a tendency is a matter of common observations. An old bentonite jelly has a perfectly definite surface and prints made in it remain for some time. Fine clay particles, immersed in water in a thin layer between glass plates, under a microscope, may be seen gathering together in clumps. These clumps finally gather together in threads and ropes. This behavior affords a plausable explanation of the curved worm-like structure frequently observed in fine clays. Longitudinal shrinkage would cause such ropes to develop the transverse lamellar structure commonly associated with them. Cakes of fine dry silt, when "melted" in water, frequently break up into flakes or grains of quite uniform diameter and thickness, much harder than the lump and not yielding to water without mechanical assistance. Forms varying all the way from mere formless lumps to decidedly crystalline structures are met with in various fine grained materials.

La Place in 1807 gave the expression

$$P + S\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

for the internal pressure at the surface of a liquid. S is surface tension (about 72 $\frac{\text{dynes}}{\text{centimeter}}$ for water at ordinary temperatures). R_1 and R_2 are the two principal radii of curvature of the surface and P the value of the pressure for a plane surface (R_1 and R_2 both infinite). Since for a thin layer of water on silica P is of the order of $17000 \times 10^6 \frac{\text{dynes}}{\text{centimeter}^2}$, at least one R must be of the order of 10^{-6} centimeter or 0.01 micron in order that the S term may not be negligible. It is this size of particle that exhibits the most marked colloidal properties. 100 times larger are the visible particles; 100 times smaller individual molecules.

In later papers it is planned to deal with the hydration, solution and dehydration of such small particles and the molecular forces involved.

PLANT CHEMISTRY.—*The presence of free methyl salicylate in some American species of* Polygala. EDGAR T. WHERRY, Bureau of Chemistry.[1]

In many works on plant chemistry[2] it is noted that certain members of the genus *Polygala* contain gaultherin, the glucoside which on being split by the appropriate enzyme liberates methyl salicylate. Except, however, for *P. Senega* and its variety *latifolia*,[3] (the latter sometimes erroneously assigned other names) no American species have been recorded as containing this glucoside, nor is it commonly recognized that by merely pulling the plant out of the ground sufficient methyl salicylate can be set free to cause the roots to exhale its characteristic odor, although the name "flowering wintergreen" sometimes applied to one of the more northern species, *P. paucifolia*, evidently refers to this feature. The following observations on a number of the species native to the eastern United States accordingly seem worth placing on record.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 29

[2] See GILDEMEISTER and HOFFMANN, Volatile Oils, 1: 505. 1899, KREMERS and JAMES, Pharm. Rev., 16: 100 1898.

[3] The nomenclature of BLAKE, North American Flora, 25. 305 1924, is followed in this article.

My attention was first called to the matter in the course of searching for a suitable common name for this genus. The writers of botanical text-books, manuals, and flower-guides have manufactured names for it, which as might have been expected from the methods used, have never come into common use. The plan preferred by some name-makers is to change a letter or two in a technical name, it being apparently assumed that laymen like a name which is not identical with the technical one, be the change ever so slight. The application of this plan to the genus *Polygala* gives "Polygale," but why this should be considered easier to use, remember, or pronounce than the correctly spelled technical name is not clear. Another favored plan is to translate part or all of the technical name, and add a more or less familiar suffix to it. In the present case, the usual result of this procedure is "Milkwort." Here the suffix is objectionable, at least for America, in that it has never attained the usage in this country that it has in England; and the root word is both non-significant, in that the syllable *gal* in the technical name was based on a misunderstanding, and incomplete, the first part of the technical name being as important as the second, so that the only correct designation on this basis is "Muchmilkwort."

Fortunately, it is not necessary to use either of these awkward words, for a real common name, i.e., one devised by laymen, has been discovered. In the course of trips in the southern states, local people were found to be using for conspicuous members of this genus, besides the form-names "Thimbles," "Buttons," etc., the terms "Candy-weed," "Candy-root," "Wintergreen," and even, quite mistakenly, "Peppermint." Inquiry as to the origin of this sort of designation led to the information that it referred to the presence of a flavoring substance evident by its odor when the roots were pulled up, and by tasting, when chewed, like "wafer-candy" (hard disks made of compressed fine sugar, flavored with various essential oils, such as those of peppermint, wintergreen, etc.). The most appropriate of these names for the genus as a whole would seem to be *Candy-root*, which may be suggested for adoption in the second edition of Standardized Plant Names (the unmodified technical name having been used in the first edition).

That the flavoring substance concerned is methyl salicylate was readily recognized. The question then arose as to whether any considerable number of members of the genus exhibited this feature and accordingly those encountered on field trips during the past few years, amounting to about three-fourths of the known species of the eastern United States, have been repeatedly examined as to the odor and taste of their roots. The results are presented in the accompanying table,

TABLE 1.—METHYL SALICYLATE IN POLYGALAS AS DETECTED BY THE ODOR AND TASTE OF THEIR ROOTS

SPECIES AND AUTHOR	WHERE STUDIED	SOIL PREFERENCE	AMOUNT
alba Nutt.	Tex -Okla	minimalkaline, dry	large
Baldwini Nutt	Fla.	mediacid, damp	large
Boykini Nutt.	Fla -La.	minimalkaline, dry	small
brevifolia Nutt	N J	mediacid, damp	large
cruciata L	Fla-La -N J.	mediacid, wet	large
cumulicola Small[4]	Fla	neutral, dry	large
Curtissii Gray	Va -Md.	subacid, dry	large
cymosa Walt	Fla -Miss -Del	mediacid, wet	none
grandiflora Walt	Fla -Miss -Ga	subacid, damp	large
grandiflora angustifolia Torr. & Gray	Ala.	neutral, dry	large
incarnata L	Fla -Pa	subacid, dry	large
Lewtonii Small	Fla.	mediacid, dry	large
Lindheimeri Gray	Tex	neutral, dry	small
lutea L	Fla -Miss.-N. J	mediacid, wet	large
mariana Mill	Fla -Md	subacid, damp	large
nana (Michx) DC	Fla -Ga	subacid, dry	large
Nuttallii Torr & Gray	Va -N J.	subacid, damp	large
paucifolia Willd.	N C -Mich -Me	minimacid, dry	large
polygama Walt	Fla -Ala -N J	subacid, dry	large
ramosa Ell	Fla -N J.	mediacid, damp	large
Rugelii Shuttl.	Fla.	mediacid, damp	large
viridescens L	Fla.-La -Md	subacid, damp	large
viridescens sanguinea (L) Farwell	Va -Pa	subacid, damp	large
Senega L	Va -Pa	minimacid, dry	large
Senega latifolia Torr. & Gray	Ark	minimacid, dry	large
verticillata L.	Fla -Ark -Me	subacid, dry	large
verticillata ambigua (Nutt) Wood	Va -Pa	subacid, dry	large

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[4] Described since the publication of Blake's article cited in footnote 3, according to the plan of treatment followed in that article, it would probably be a variety of *P. grandiflora* Walt.

and, as will be seen, all but one of the 27 native species and subspecies which have been studied contain some substance from which methyl salicylate is readily set free. No laboratory studies have been made upon these, although there seems no reason to doubt that the glucoside gaultherin is the primary source. The one exceptional species, *P. cymosa,* has seeds rather dissimilar from those of the others in its section, and is probably not very closely related to them.

There are three plants of other families, in which the same phenomenon can be observed, growing more or less commonly in the region covered, namely Sweet Birch (*Betula lenta*), Wintergreen (*Gaultheria procumbens*), and American Field-Violet, (*Viola rafinesquii*). The presence of methyl salicylate in the last does not seem to have been hitherto recorded, but it is interesting to note that some European violets are known to contain gaultherin, and possibly other American species may be found to do so.

BOTANY.—*The Central American species of* Hydrocotyle.[1] J. N. ROSE and PAUL C. STANDLEY, U. S. National Museum.

The genus *Hydrocotyle* is a small group of the family Apiaceae or Umbelliferae, widely distributed in both hemispheres, and in both North and South America. Although some species grow in the tropical lowlands, most of them are natives of the temperate regions, and in the countries lying near the equator the Hydrocotyles are best represented in the cool mountains. The Central American species have not been revised recently, and, indeed, a satisfactory treatment of them would have been impossible for lack of adequate material. Recent explorations in Central America, particularly in Costa Rica, have resulted in assembling a large number of specimens, so that it is now possible to understand the various forms represented in the region. Of the eight species which we have recognized from the Central American area no less than four appear to be new, and they are here described. It is altogether possible that further exploration may reveal the occurrence of still other localized species, like *H. ribifolia* and *H. Torresiana,* each of which, although represented by several collections, is known from only a single limited locality.

KEY TO SPECIES

Leaves peltate.
  Umbels compound.................................**1. H. bonariensis.**

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received January 29.

Umbels simple.
  Petioles glabrous; pedicels usually much longer than the fruit; lateral ribs of the fruit evident.. ....2. **H. umbellata.**
  Petioles villous; pedicels shorter than the fruit; lateral ribs nearly obsolete.................. .... 3. **H. costaricensis.**
Leaves not peltate.
 Petioles glabrous; leaves deeply lobed, the lobes very obtuse. 4. **H. ranunculoides.**
 Petioles villous or puberulent; leaves not lobed or, if lobed, the lobes acute.
  Leaves angulato-lobed, the lobes elongate, acute or acutish. 5. **H. ribifolia.**
  Leaves orbicular, not lobed or with very shallow, broadly rounded lobes.
   Flower sessile ....6. **H. Torresiana.**
   Flowers on evident pedicels.
    Peduncles densely puberulent; pedicels usually longer than the fruit, often several times as long....... . 7. **H. mexicana.**
    Peduncles thinly villous; pedicels equaling or shorter than the fruit.. ....8. **H. Maxonii.**

1. **Hydrocotyle bonariensis** Lam. Encycl. 3: 153. 1789.

GUATEMALA: Lake Amatitlán, *J. D. Smith* 2200. Without definite locality, *Watson* 36a.

PANAMA: Chagres, *Fendler* 132.

2. **Hydrocotyle umbellata** L. Sp. Pl. 234. 1753.

GUATEMALA: Laguna de Caldera, Volcán de Pacaya, *Tonduz* 476. Near Guatemala, *Tonduz* 813. Puerto Barrios, *Deam* 6013. Amatitlán, *J. D. Smith* 2668. San Lucas Tolimán, *Holway* 190. Finca Sepacuité, *Cook & Griggs* 187. Santa Rosa, *Heyde & Lux* 3349.

SALVADOR: Ixtepeque, *Standley* 21458. Ateos, *Standley* 23366.

HONDURAS: Amapala, *Standley* 20747.

NICARAGUA: Granada, *Baker* 621.

COSTA RICA: San José, *Holway* 259; *Standley* 32166. Río Reventado, near Cartago, *Standley & Valerio* 49550. Las Cóncavas, Prov. Cartago, *Standley* 35984.

PANAMA: Valley of Río Panduro, *Killip* 3577. Matachín to Las Cascadas, *Cowell* 356.

In Costa Rica the plant is called "sombrerito," in Salvador "lechuga."

3. **Hydrocotyle costaricensis** Rose, sp. nov.

Stems very slender, creeping, elongate, sparsely villous with long whitish hairs or glabrate, the nodes 1–3 cm. long; petioles slender, 1–3 cm. long, densely retrorse-villous, at least above, with long white hairs, leaf-blades peltate, orbicular, 1–2 cm. broad, very shallowly crenate-lobate, the lobes crenate, the crenations few, broadly rounded, the blades glabrous on both surfaces; peduncles filiform, 5–10 mm. long, glabrous; flowers few, sessile or on pedicels less than 1 mm. long; petals pink; fruit didymous, nearly 1.5 mm. broad, emarginate at base and apex, turgid, nearly twice as broad as high, glabrous, obscurely tuberculate, the lateral ribs obsolete.

Type in the U. S. National Herbarium, no. 1,180,225, collected on roadside bank near La Palma, Province of San José, Costa Rica, altitude 1,500 to 1,700 meters, July 17, 1923, by William R. Maxon (no. 7902). The following additional collections may be cited:

COSTA RICA: Las Nubes, *Standley* 38402. Without definite locality, *Pittier* 10353. Santa María de Dota, *Standley* 41572; *Standley & Valerio* 43341. Between San Pedro and Curridabat, *Standley* 32810. San Sebastián, *Standley* 32747. Alto de la Estrella, *Standley* 39291.

PANAMA: Balboa, a weed in garden, doubtless introduced, probably from the mountains of Panama, *Standley* 28563.

Hydrocotyle costaricensis is closely related to *H. pusilla* A. Rich., a species of the West Indies and South America. The latter is distinguished by the villous upper surface of the leaves

4 **Hydrocotyle ranunculoides** L. f Suppl. Pl 177. 1781.

NICARAGUA· Without definite locality, *C. Wright*

COSTA RICA La Verbena, *Standley* 32220. Santa María de Dota, *Standley & Valerio* 44136. Río Reventado, near Cartago, *Standley & Valerio* 49626.

PANAMA Changuinola Valley, *Dunlap* 226.

5. **Hydrocotyle ribifolia** Rose & Standl , sp. nov.

Plants large and coarse, prostrate or widely creeping, the stems 30–100 cm. long or more, with elongate internodes, copiously villous with long spreading hairs, stipules 4–5 mm. long, oval or broadly ovate, scarious, glabrous, the margins lacerate, petioles 4–13 cm. long, villous with long slender spreading yellowish hairs, leaf blades pentagonal, 5–9.5 cm. broad, deeply cordate at base, with a deep narrow sinus, 5-lobate to about the middle, the lobes broadly ovate, acute or acutish, shallowly lobate, the lobes irregularly crenate or crenate-serrate, rather densely villous on both surfaces with spreading yellowish hairs, peduncles very slender, 2 5–4.5 cm long, glabrous, flowers numerous, greenish, the pedicels filiform, 2 5–4 mm. long, glabrous; fruit 1 5 mm long (one of the carpels usually abortive), shallowly emarginate at base and apex, glabrous, the lateral ribs slender but distinct.

Type in the U. S. National Herbarium, no. 1,253,273, collected in moist forest on Cerro de las Vueltas, Province of San José, Costa Rica, altitude 3,000 meters, December 31, 1925, by Paul C. Standley and Juvenal Valerio (no. 43506). The following collections also represent the species

COSTA RICA. Cerro de las Vueltas, *Standley & Valerio* 43749, 43799.

This plant is very unlike anything known heretofore from North America, and it does not approach closely any South American species of which material is available.

6. **Hydrocotyle Torresiana** Rose & Standl , sp. nov.

Plants slender, creeping, the stems 10–30 cm. long, rooting at the nodes, with elongate internodes, sparsely villous with slender spreading hairs; stipules 2 mm. long, rounded or broadly ovate, scarious, whitish, glabrous, the margin irregularly dentate or lacerate; petioles 2–4 cm. long, slender, thinly villous with long slender spreading hairs, leaf-blades reniform-orbicular, 1–2 5 cm. broad, deeply cordate at base, with a V-shaped sinus, very shallowly 5-lobate, the lobes broad, dentate with short ovate obtuse irregular teeth, short-villous on both surfaces with white hairs; peduncles slender, 1–2 5 cm. long, sparsely villous; flowers sessile or very nearly so, purplish, numerous; fruit heads globose, very dense, 4 mm. in diameter; fruit 1 mm. long, much broader than long, glabrous, the lateral nerves obsolete.

Type in the U S. National Herbarium, no. 1,226,942, collected in potrero on the southern slope of Volcano of Turrialba, near the Finca del Volcán de Turrialba, Costa Rica, altitude about 2,400 meters, February 22, 1924, by Paul C. Standley (no. 34950). Nos. 35232 and 35105, from the same locality, represent this plant.

The species is named for Prof. Rubén Torres Rojas, in whose company the specimens were collected.

7. **Hydrocotyle mexicana** Cham. & Schlecht. Linnaea 5: 208. 1830.

Guatemala: Río Negro, Depart. Quiché, *Heyde & Lux* 3350. Volcán Acatenango, *Kellerman* 5244, 4801. Volcán Atitlán, *Kellerman* 5771; *Holway* 189. Cobán, *Tuerckheim* 8688, 685. Between San Martín and Todos Santos, *Nelson* 3623. Volcán Santa María, *Nelson* 3702. Near Secanquím, *Goll* 156.

Salvador: Volcán de San Vicente, *Standley* 21488.

Nicaragua: San Rafael del Norte, *Miller & Griscom* 4, 53, 104.

Costa Rica: La Palma, *Maxon & Harvey* 8063. Las Nubes, *Standley* 38501, 38617, 38828, 38525. La Hondura, *Standley* 36175, *Standley & Valerio* 51902. Tuis, *Tonduz* 11414. Cerro de la Carpintera, *Standley* 34312. Between Aserrí and Tarbaca, *Standley* 34165, 41387. Los Ayotes, *Standley & Valerio* 45387. El Muñeco, *Standley* 33506, *Standley & Torres* 51255. La Estrella, *Standley* 39317, 39177. El Silencio, *Valerio* 56; *Standley & Valerio* 44566. Laguna de la Chonta, *Standley* 42278. Santa María de Dota, *Standley* 42510, 41807, 42110. Pejivalle, *Standley & Valerio* 46740. Yerba Buena, *Standley & Valerio* 49968, 49797. Cerro de las Caricias, *Standley & Valerio* 52064. Quebradillas, *Standley* 42930

Panama. Above El Boquete, *Maxon* 5644. Cana, *Williams* 783.

8. **Hydrocotyle Maxonii** Rose, sp. nov.

Plants slender, creeping, with elongate internodes, the stems rooting at the nodes, glabrous; petioles slender, 3–15 cm. long, sparsely villous with long slender spreading white hairs; leaf-blades orbicular, 1–4 cm. broad, deeply cordate at base, with a narrow V-shaped sinus, sparsely villous on the larger nerves, sometimes glabrous on the upper surface, very shallowly 5-lobate, the lobes broadly rounded, distantly crenate; peduncles slender, 5–16 cm. long, often exceeding the leaves, villous with long spreading white hairs; flowers numerous, greenish, the pedicels 1–1.5 mm. long, glabrous; fruit heads very dense, globose, about 7 mm. in diameter, fruit 1.5 mm. wide, broader than long, somewhat obcompressed, broadly rounded or truncate at base and apex, glabrous, the lateral nerves slender but distinct.

Type in the U. S. National Herbarium, no. 1,180,226, collected on stony wet roadside near La Palma, Costa Rica, altitude 1,500 to 1,700 meters, July 17, 1923, by William R. Maxon and Alfred D. Harvey (no. 8047). The following additional collections have been examined:

Mexico. Choapam, Oaxaca, *Nelson* 864.

Guatemala: Finca Mocca, Alta Verapaz, *Johnson* 54.

Costa Rica. El Muñeco, *Standley* 33478, *Standley & Torres* 50906. La Palma, *Standley* 33160, 38218, 38112, 32891. La Estrella, *Standley* 39382, 39169. La Colombiana, *Standley* 37302, 36694. Guápiles, *Standley* 37024. Pejivalle, *Standley & Valerio* 46838, 46782. La Hondura, *Standley* 37584, 36147; *Standley & Valerio* 51904. Naranjos Agrios, *Standley & Valerio* 46414. Hamburg Finca, *Standley & Valerio* 48834. Tuis, *Tonduz* 11413. San Pedro, *Tonduz* 17838. Quebrada Gata, *Brenes* 14450. Mountains of Candelaria, Feb., 1847, *Oersted.* Río Reventado near Cartago, *Standley & Valerio* 49562.

Although closely related to *H. mexicana*, this plant is easily distinguished by the characters given in the key. The numerous specimens examined are at once referable to one or the other of the two species, and there are no intermediate forms.

PALEONTOLOGY.—*The Occurrence of* Lituonella *and* Coskinolina *in America.*

JOSEPH A. CUSHMAN, Sharon, Massachusetts.[1]

In an earlier volume of this Journal, Woodring[2] noted the occurrence of the conical foraminifer *Dictyoconus* in Haiti and later described two new species and a new variety. These occur in the Middle Eocene, as does the genus in the Mediterranean region. Some years ago, in studying well-samples from Florida, I found both conical and more flattened foraminifera which seemed to belong to the Cretaceous genus *Orbitolina* and to certain other arenaceous "Buliminas" similar to species characteristic of the Lower Cretaceous. Since that time a more careful study of species of *Orbitolina* and of sections of the Florida specimens has convinced me that the determination of the latter as *Orbitolina* was incorrect and that the beds containing them are of Middle Eocene age. A year or more ago, in studying the essential characters of *Lituonella* and *Coskinolina,* I came to the conclusion that specimens from the Florida wells could be referred to both these genera. In addition the "Buliminas" are now known to belong either to *Valvulina* or to a newly erected genus *Arenobulimina,*[3] which have affinities with Cretaceous species and, superficially at least, resemble them in many ways. Silvestri has erected a new genus *Cushmania* based on my *Conulites americana* from the Eocene of the Leeward Islands. This genus also appears to occur in the Florida well-samples. The relationships of these different genera are very interesting, as the following paragraphs indicate.

Valvulina is triserial with a large aperture and a flattened tooth. The species in the material under discussion, which occurs below the Ocala limestone, is in the young flattened on the three sides and appears to be an ancestral form of *Valvulina ocalana* Cushman.

In *Arenobulimina* the early stages are triserial; in the adult several more elongate chambers make up each whorl and the test broadens. Species of this genus also occur in the well-samples.

Lituonella has the early stages like those in *Arenobulimina* but by acceleration these are passed through quickly in the development of the test. In the adult the chambers become discoid and the test is made up of a series of these disc-like chambers gradually increasing in size as each is added. The aperture is multiple, on the basal face. The later discoid chambers are labyrinthic but there seems to be no

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[1] Received February 15, 1927.

[2] This JOURNAL 12: 244–247. 1922.

[3] CUSHMAN, Contr. Cushman Lab. Foram. Research 2(4): 80. 1927.

distinct division into a cortical and an interior set of chambers. At the apex of each specimen there is a miniature *Arenobulimina*. Specimens such as are figured by Schubert[4] occur in several of the Florida wells and do not seem to differ specifically from *Lituonella liburnica* (Stache), described from the Middle Eocene of the Istrian-Dalmatian coast.

Specimens in the well-samples also seem to be identical with *Coskinolina liburnica* Schubert, from the Middle Eocene of the Istrian-Dalmatian coast. The early eccentric young stages are very well preserved in some of the specimens, and the general form and size is so close to Schubert's species that there seems nothing to separate them. Sections show the same simple irregular arrangement of the interior chamberlets and, although the exterior when worn shows the radial division of the subsurface of the discoid chambers, there are no such definite divisions as occur in *Dictyoconus* or *Chapmania* and the walls are simple.

Occurring with *Coskinolina* is a large species as much as 3 millimeters in diameter, with the apex a sharp cone, the sides thence concave, and flaring at the base with the basal face convex. The peripheral portions of the chambers end in fine tubuli. The species is apparently the same as that from the Leeward Islands described by me as *Conulites americana* but to which Silvestri has given the generic name *Cushmania* and which should be known as *Cushmania americana* (Cushman). The early stages appear to have the chambers arranged as in *Coskinolina* and it is probable that it came from that genus, in which case the developmental series would be: *Valvulina—Arenobulimina—Cribrobulimina—Lituonella—Coskinolina—Cushmania.*

In some of the wells at somewhat lower levels a species occurs which is much flattened and has a concave base. I take it to be *Dictyoconus codon* Woodring, already described from the Middle Eocene of Haiti. In this species the outer chambers are divided so that there are two layers of chamberlets in each chamber, a structural feature much more like that of *Orbitolina* than of the other genera already considered.

Altogether this makes four genera of the conical foraminifera represented in these Middle Eocene strata of Florida, two of which, *Lituonella* and *Coskinolina*, have previously been unknown in the Western hemisphere.

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[4] Jahrb geol. Reichsanstalt **62**: *pl. 10, f 10, 11.* 1912.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY

423D MEETING

The 423d meeting was held at the Cosmos Club January 12, 1927, President BUTTS presiding. The Secretary announced the election to active membership of W. N. WHITE and A. M. PIPER both of the U. S. Geological Survey, and also the resignation of FRANK TWEEDY and S. W. BEYER.

Program. PROFESSOR J. HARLAN BRETZ, University of Chicago: *Channeled scabland and the Spokane flood.* That part of the Columbia Plateau which lies north of Snake River in Washington bears a remarkable system of erosional and depositional land forms. They are extraordinary in their magnitude, in their extent and distribution, and unique in their relationships. Running water is generally conceded to have caused them but the unparalleled results indicate unparalleled conditions under which it acted.

The channeled scablands constitute the erosional part of the record. They cover almost 2000 square miles, about ⅕ of the area of this part of the plateau. They are elongate tracts, oriented with the gentle dip slope of the underlying basalt flows, mostly bare rock or with a thin cover of coarse basaltic rubble, commonly with canyons in them, and are bounded by steep slopes of the deep loessial soil of the plateau. They constitute a curious anastomosing pattern, the down-dip convergences inherited from an earlier normal drainage pattern and the divergencies, equally numerous, produced by crossing of divides of this older pattern. There are hundreds of tracts of the higher loess-covered areas in the scablands, from a fraction of a square mile to many townships in area, all discontinuous and bounded by the scabland areas. The steep marginal slopes in loess are in striking contrast to the gentle slopes of the older drainage pattern surviving within each isolated loessial tract. Canyons in the scablands are multiple and anastomosing, amazingly so in some tracts; deep canyons and shallow ones uniting and dividing in a labyrinthine fashion about bare rock knobs and buttes unlike any other land surfaces on the earth. Certainly but few of these canyons are inherited from the older pattern.

The scabland drainage was discharged from the northern glaciated portion of the plateau through ten openings into the loess-covered area and led thence by nearly one hundred different routes of varying lengths to nine dischargeways into Snake and Columbia rivers on the south and west. The canyon plexus is the most striking feature of the scablands and probably is most significant of conditions of origin. These canyons are interpreted as channels, not valleys, hence the term "channeled scabland."

The depositional land forms associated with channeled scabland are chiefly great mounded masses of little worn basaltic gravel. They occur on the down-gradient side of eminences and in other protected places in the scablands, and in the Snake and Columbia valleys below the entrance of the scabland drainage routes. They are not eroded forms, they possess aggradational slopes and they inclose depressions or by their position aid in inclosing depressions between themselves and adjacent rock walls. All attempts to interpret them as dissected remnants of terraces or originally continuous gravel deposits have failed. They are gravel bars of huge size.

A brief summary concerning the more significant features and relationships follows.

CANYONS OF THE SCABLANDS. Largely channels of huge rivers, eroded during the Spokane epoch.

A—Rock basins in the canyons Thousands of them. Commonly elongate with the canyons, generally constituting the canyon floor Lengths as great as eight miles, depths as great as 200 feet. Some canyon floors essentially a series of rock basins. Formed by large vigorous streams plucking the columnar basalt. In no other way can most of these basins be explained. Some are potholes at the foot of extinct waterfalls.

B—Plexus grouping of canyons. Occur on crossings of divides of the older drainage pattern, the four largest groups ranging from 6 to 10 miles wide. Developed subfluvially like the high-water anastomosing channels of the present Columbia at the Dalles. Alternative explanation demands a remarkably braided pattern of an eroding stream, with narrower strands in many cases cutting deeper than broader ones.

C—Cataracts. Hundreds of extinct waterfalls, many of which during recession became wider, several two to three miles wide. Unless the record of very large streams, they should show the "horseshoe" concentration from any initially great width.

AREAS SURROUNDED BY THE CHANNELED SCABLAND TRACTS. Residuals of a once continuous loessial cover, with maturely eroded drainage ways. 100 to 200 feet of loess removed over large areas.

A—Aligned scarps of loess facing the scablands. Slopes 30° to 35°. The bluffs left by undercutting of streams whose width was that of the adjacent scabland, from half a mile to 15 miles. They truncate minor valleys of the older drainage pattern.

B—Small isolated loessial hills on the scabland. Slopes as above indicated, with "prows" pointing up the scabland gradient. Some are miles from any other loess. Others, in groups, record abrupt introduction of a large volume of water which simultaneously entered several of the pre-Spokane drainage ways and eroded them to bedrock, leaving these remnants of the former divides

TRENCHED DIVIDES. Several remarkable cases where a canyon plexus has three or four closely spaced rock-basined gashes 200 to 400 feet deep across a divide, yet only one case where one of them cut deeply enough to divert subsequent drainage. Water must have been 100 to 300 feet deep above preglacial valley bottoms on the north to have crossed. No piracy nor headward erosion nor local drainage has been responsible Good evidence that no post-Spokane uplift has occurred in these places

DEPOSITS ON THE SCABLAND AND IN SNAKE AND COLUMBIA VALLEYS. Discontinuous originally. Their features clearly record actual building of each individual deposit Any explanation must start with this.

A—Gravel chiefly. Pebbles little worn, 90 to 99 per cent basalt, unweathered.

B—High deposits, above brink of canyons 400 feet deep and at foot of loessial scarps, yet identical with other deposits down in the canyons.

C—Bar forms, undissected, foreset bedding conforming to slopes where required by this hypothesis. Associated depressions as much as 50 feet deep where vigorous eddies existed. Some bars, 20 to 100 feet high, blocked subsequent drainage.

D—Deltaic bar, 5 miles long and 200 feet thick in Snake and Tucannon valleys, with foresets dipping up these valleys from point of entrance of scabland stream. In striking contrast with Snake River gravels immediately upstream, which are in 60-foot terraces, dissected and with large alluvial fans built out on them, and are composed of 90 to 95 per cent nonbasalt, well-rounded gravel.

E—Quincy structural basin. More than 15 townships covered with basaltic gravel in terrace-like and mesa-like forms. Channeled canyons tributary to and distributary from this settling basin. The forms, however, are bars, as field study has amply demonstrated. No interpretation as terraces will account for many significant relationships.

ANASTOMOSIS OF ENTIRE SCABLAND TRACT ON THE PLATEAU. Contemporaneous occupation of all scabland routes seems indicated. No evidence on glaciated tract of marginal drainage to supply, in turn, any one or two of ten entrances to the scabland during any conceivable shifting of ice edge. All channels seem to have headed on margin of the glaciated tract. Anastomosis due to the huge volume of glacial water and the abrupt introduction, thus flooding a multitude of minor drainage ways of the plateau and crossing a multitude of minor divides. Insufficient time for eroson of a few adequately capacious spillways. Debouchure into Snake and Columbia valleys at very different levels, indicating varying depth of different channelways and a lowering water-level in these valleys during the discharge.

WALLULA GATEWAY HIGH-LEVEL SCABLAND. A short narrow canyon south of junction of Snake and Columbia Rivers, 20 miles from nearest plateau scabland. Yet with same features of subparallel lateral canyons, rock basins, knobs and buttes as high on canyon walls as in the Snake and Columbia upstream. All scabland drainage passed through this canyon and the flood reached 900 feet above present river bottom, perhaps 650 feet above canyon bottom at beginning of Spokane episode. Constriction here caused the ponding recorded in lower scabland tracts on plateau and made possible the plexus crossings of divides. Erosion of Gateway canyon was rapid enough to lower the ponded waters while the scabland rivers were still running. No other conceivable cause of ponding is indicated elsewhere in the Columbia valley below the plateau.

COLUMBIA VALLEY BELOW WALLULA GATEWAY. For 150 miles a descending series of scabland tracts and gravel deposits in Columbia valley.

A—Bars in mouths of tributaries. Basalt gravel, ranging in height up to 600 feet above the Columbia. Delta foresets which prevailingly dip back into tributary mouths.

B—Portland delta, area 200 square miles, foreset-bedded throughout, basalt, gravel channels and great bars, remarkable eddy depression on upstream side of a rock island in the delta.

There are many apparently possible alternative explanations for the remarkable features of the preceding list. Virtually every one of these, when applied, involves exceptional combinations of factors and no one of them will explain more than one or two of the fifteen listed phenomena. Most of them have been tested in the field and rejected. These extraordinary features must be treated as a *genetic system*. Their assemblage on, and limitation to, this little corner of the globe cannot be coincidence, as required by alternative hypotheses. The only genetic interpretation yet proposed which is inherently harmonious and which fits all known facts is that of a great flood of water abruptly issuing from the Spokane icesheet. The unfilled rock basins with gravel bars perched on their walls indicate abrupt cessation of this flood.

The cause of this Spokane flood is unknown. It may have been a "Jökullaup" or glacier flood produced by subglacial vulcanism but this hypothesis must stand or fall on field data not yet secured. (*Author's Abstract.*)

Discussion: W. C. ALDEN: Professor Bretz frankly points out the difficulties met in applying his explanation of the origin of the remarkable features of the Columbia plateau. It is not easy for one, like myself, who has never examined this plateau to supply offhand an alternative explanation of the phenomena. I have read Professor Bretz's papers on the subject with great interest but I am left with the feeling that some things essential to the true explanation of the phenonena have not yet been found. The "channels" appear to be due to stream erosion. The main difficulties seem to be (1) The idea that all the channels must have been developed simultaneously in a very short time; and (2) The tremendous amount of water that he postulates as coming from the melting of the ice sheet in so short a time to do the work. It seems to me impossible that such part of the great ice fields as would have drained across the Columbia plateau could, under any probable conditions, have yielded so much water as is called for in so short a time. It also seems as though the estimated capacity of the Wallula Gateway, when fully opened, is too great for this gorge to have served as a bottle neck to hold above it a flood of such dimension to the level called for in the explanation offered. It appears that ice sheets of three distinct stages of glaciation invaded the borders of this region and may have afforded conditions of repeated floodings of much smaller volume. It would seem that a more extended study of the glacial phenonena is required about the heads of the scabland "channels" to determine, if possible, more exactly just what sort of glacio-fluvial discharge actually occurred. Perhaps the explanation of the phenomena does not actually necessitate contemporaneous development of all the "channels," nor in so short a time. The problem would be easier if less water was required and if longer time and repeated floods could be allotted to do the work. The conditions of repeated glaciation in the basins of Clarks Fork and the Columbia are not yet well enough understood to afford very sure bases for postulations as to stream flow therefrom. It is important and highly desirable that means may be provided for a more extended study of the Pleistocene phenomena of these basins and of the adjacent mountains.

JAMES GILLULY: The question of the existence of a Spokane flood rests on the interpretation of many highly abnormal field facts. The evidence presented by Professor Bretz is assuredly convincing as to (1) the anomalous, indeed unique, drainage features of the Columbia Plateau, (2) their direct dependence upon glacial waters, and (3) the necessarily large volume of many of these streams. However, certain criteria used to determine the actual quantities of water involved appear somewhat questionable. Both Russell and Jenkins have recognized a ponded condition of the Snake River at Wallula Gateway, but Russell has attributed it to monoclinal deformation rather than to a flood, and, while Jenkin's views are not clear, he presumably agrees with Russell. Presumably then, without definite evidence to negative this theory, scoured basalt at high levels here is not conclusive of a sudden deluge of Spokane waters. The overflow may well be much older than Spokane glaciation. The evidence presented by Professor Bretz to fix the Wallula cutting as Spokane and not earlier is the height of talus. In an article published in 1925 he pointed out that "most of the talus (at Wallula Gateway) is higher than three-quarters though some is typical." Thus the date of the overflow is not fixed accurately as the date of the Spokane glaciation, even if we grant that the three-quarter talus criterion of age elsewhere applied by him is valid.

This talus criterion, however, is very doubtful as an accurate time gauge on several counts: (1) The range in rainfall from point to point on the plateau is from 5 to 20 inches. If three-quarters talus is found at both places it appears then that the height is probably a relatively stable stage in topographic development, rather than a measure of total elapsed time since the cliffs were formed (2) The validity of the criterion depends on the assumption that all fragments falling from the cliffs remain in the talus heaps. This assumption is assuredly unwarranted, for in the formation of talus rock is disrupted into finer fragments, which waste by weathering and are subject to removal by wind and by even the most ephemeral streams. The Colorado Plateau offers numerous examples of cliffs which have retreated scores of miles yet still have vertical faces. Similar tendencies must prevail here, although basalt is decidedly more resistant than those sandstones. (3) The well known differences in rate of weathering of canyon walls dependent on their directional trends also give one pause in accepting uniform talus heights as more than a very rough measure of the age of cliffs. If the talus is of uniform height in both east-west and north-south canyons it strengthens still farther the suggestion that the three-quarters stage of talus is relatively stable, rather than a good time measure. (4) Even disregarding these three points which appear to me of great cumulative importance as tending to throw doubt on the validity of the talus age criterion and accepting Professor Bretz's analysis, elapsed time since a cliff was formed varies as the square of the proportional talus heights. Seven-eights talus then means 49/36 as great age (or 134 per cent) as three-fourths talus. Wallula Gateway, a narrow gorge for a great river, is likely to have had its talus sapped from time to time in its history, so that even granting that three-quarters talus is ordinarily valid as a time measure (which for the reasons stated above is very doubtful), the flooding of the top walls of the Gateway is probably pre-Spokane, and the deepening of the canyon a much longer process than granted by Bretz. This idea is strengthened by considering the quantitative factor. According to Bretz's old measurements the discharge at Wallula Gateway was 38 9 cubic miles per day, or over 50 times the present flood volumes of the Columbia and, proportionally to drainage basin, over 200 times as large as the greatest recorded floods of the Mississippi. Now he believes the water reached even greater height and hence must have produced a still greater flood. To explain this great flood without retreat of the ice front, he has suggested—(1) a very sudden climatic amelioration (only to rule it out as very improbable) and (2) that subglacial volcanism resulted in sudden melting of large quantities of ice which formed the flood. This mechanism is wholly inadequate as, even allowing most generous thermal properties for basalt and perfect efficiency of transfer of this heat for melting the ice, even a 10-day flood would require 17 cubic miles of basalt or a layer about 9 feet thick over 10,000 square miles. Further computations show that the rate of cooling of basalt is so slow that if we assume the subglacial surface replaced by molten basalt it would require over 9,700 square miles of basalt exposure beneath the ice to produce only 350 cubic miles of water which would only maintain the flood postulated by Bretz for ten days. But the areal geology of the Columbia basin is sufficiently well known to completely eliminate any possibility of late Pleistocene volcanism of such magnitude. Even this preposterously low estimate of flood duration is eliminated by the physical factors (such as resistance of basalt, depth of channels above Wallula referred to that constriction and others) involved. How much less competent then, must we admit is the jokullaup hypothesis to furnish the tremendous flood volume postulated by Bretz. The incompetence of the postulated mechanism to furnish the flood volume required by Bretz's interpretations of the field evidence seems to call for a reinterpretation of that evidence. That, as suggested by G. O. Smith, Meinzer, and Ferguson, such a reinterpretation is apt to be considerably more complex than the suggested flood hypothesis, seems exceedingly probable. That the actual floods involved at any given time were of the order of magnitude of the present Columbia's, or at most a few times as large, seems by no means excluded by any evidence as yet presented.

E. T. McKnight: Three dry coulees cut southwestward from the "Othello channels" at the east end of the Saddle Mountains in central Washington across the aggraded surface of the Ringold formation and debouche at varying elevations as hanging valleys along the White Bluffs of the Columbia. All are markedly U-shaped in cross section. The master channel of the three is Koontz Coulee which debouches at Ringold at an elevation of 150 feet above the river. It is 1½ miles wide in its lower and better defined portion and its bed lies from 200 to 300 feet below the flat undissected Ringold plain which borders it abruptly on the northwest. In its upper half it has cut through the soft Ringold sediments and has exposed the underlying basalt in the form of scablands The two remaining dry coulees are of comparable size, averaging less than half a mile in width and from 75 to 150 feet in depth, much smaller than Koontz Coulee. They head at essentially the same point in the west rim of Koontz Coulee, 10 miles above its mouth, at an elevation of 250 feet above its bed, and after following divergent courses reach the bluff of the Columbia at points 2 and 15 miles, respectively, above the mouth of Koontz Coulee and at elevations of 425 and 300 feet, respectively, above the Columbia. Both in turn show remnants of still shallower braided channels at higher levels, appearing as short shunts off of the primary channels. The southernmost dry coulee maintains its U-shape practically up to the point where its profile breaks off abruptly to the level of the Columbia; the enclosing walls of the northern coulee, on the contrary, begin to recede diagonally and to flatten at a point 5 miles back from the river so that the incised character of the coulee is soon lost, though the old drainage line can still be traced through to the bluff overlooking the town of White Bluffs.

That all three of the dry coulees above described were produced under climatic conditions widely different from those prevailing at the present time is amply proved by the sage-covered depressions in the two smaller coulees, and by the scattered depressions in the upper regions of Koontz Coulee. Mr. Bretz has interpreted these dry coulees as the product of huge glacial torrents that emptied into the Columbia when its flood waters stood at or slightly above the levels of the present debouchures of the coulees. That these are at different levels is believed to be due to the different stages in which they were abandoned during the lowering of the flood of the Columbia, Koontz Coulee being the last one abandoned. The bed of the river at the time of this flood is believed to have been at essentially its present level. The writer believes that the three dry coulees were formed by glacial waters at a time when the Columbia lay several miles west of its present channel and have been converted into hanging valleys by the lateral shift of the river to the east against the soft sediments of the White Bluffs. That this lateral shift is a reality is proved by the vigorous manner in which the river is at present undercutting the bluff, producing numerous land slides, and by the fact that the Ringold formation of pre-glacial Pleistocene age, has been largely removed by lateral planation from the region west of the river although it formerly filled the basin as far west and southwest as the Yakima and Rattlesnake ranges, 15 to 20 miles southwest of the White Bluffs. The shift of the river is down the slope of the pre-Ringold basalt floor. Restoration of the profile of Koontz Coulee indicates that the Columbia lay 3 miles west of its present position when the coulee was formed. The two smaller coulees at the higher level are interpreted as distributaries formed when Koontz. Coulee lay at that level and abandoned after it had gained the mastery.

It is believed that the explanation of Mr. Bretz is inadequate to explain (1) the fact that the two smaller dry coulees previously described, although heading at the same place, reach the White Bluffs above the Columbia at different elevations; (2) the fact that a V-shaped valley along the southern base of the Saddle Mountains, which was produced entirely by drainage off of the southern slope of the mountains, also forms a hanging valley 275 feet above the Columbia, although in this case, as with the northernmost glacial coulee, the south slope of the valley breaks back several miles from the river so that the lower course of the old drainage is almost obliterated. Mr. Bretz interprets the coarse stream gravels and cobbles that cover extensive areas west of the river at White Bluffs and Hanford as the debris of the Spokane flood. The writer believes them to be the normal channel deposits of the Columbia during its eastward shift over the area in pre-glacial, glacial, and post-glacial times. The features described in this summary appear on the Scootenay Lake, Hanford and Coyote Rapids quadrangles.

G. R. MANSFIELD: Mr. Bretz cites the occurrence of numerous anastomosing channels, with associated rock basins, some of which are 8 miles or more long, carved in basalt to depths of 200 feet or more, and locally on some divides as deep as 400 feet; he notes the occurrence of hundreds of abandoned waterfalls with "potholes" at their bases, also in basalt, and speaks of the recession of some of these falls; and yet he ascribes all these phenomena to a single flood of relatively brief duration. Basalt is a hard rock and very resistant to corrasion, but it possesses a well known columnar jointing, which supposedly renders it susceptible to undermining and to plucking, and Mr. Bretz relies on this property to account for the unprecedented rapidity of erosion of the basalt which his hypothesis requires. I am not convinced that so much work could be done on basalt in so short a time, even by such a flood as is postulated. The Dalles of the Columbia, which Mr. Bretz says are typical scabland channels, and the various falls in Snake River, can furnish pertinent and definite evidence with regard to rapidity of erosion and of the recession of falls in basalt if systematic observations are carried on for a few years. It does not seem to me neccessary to assume that all the scabland channels, or even that all parts of the same channels were occupied by water at the same time. Mr. Bretz notes that deep and shallow canyons unite and divide in labyrinthine fashion. Possibly some of the shallower channels were formed earlier than some of the others and now hang on the sides of more favorably located channels. Mr. Bretz based much of his argument for contemporaniety of all the channel phenomena upon the relative heights of talus piles beneath basaltic cliffs along the canyon sides. Probably few, if any, direct observations are available regarding the rate at which talus piles in basalt may form. From such observations as I have made in basaltic country in the past fifteen years I should say that the rate is so slow that considerable time intervals would fail to register significant differences. Such a measuring stick should not be applied too rigidly. Again contemporaneity of erosion can not well be assumed from the identity of materials composing high level and low level gravel bars. Since all the material, high or low, may be presumed to have come from much the same general sources, identity is to be expected. Some differences in state of weathering might be looked for if the time interval between high level and low level deposits was great, but even here other factors such as texture and mineral composition of the rock fragments would enter in and mere differences in weathering would not be conclusive. The general nature of the phenomena suggests conditions similar to those attending the ice front in New York State, where temporary channels and falls now abandoned were developed. Although these were temporary, geologically speaking, some of them appear to have persisted for long periods of years. The scablands seem to me better explained as the effects of persistent ponding and overflow of marginal glacial waters, which changed their position or their places of outlet from time to time through a somewhat protracted period. Not enough is known in detail of the glacial geology and physiography of the region to furnish an adequate basis for any connected story of events here. The hypothesis of a single tremendous flood should not be accepted without further detailed regional study.

O. E. MEINZER. I have seen only the part of the region under discussion, that including Quincy Valley, Grand Coulee, and Moses Coulee. As Doctor Bretz has stated, the erosion features of the region are so large and bizarre that they defy description. However, the Columbia River is a very large stream, especially in its flood stages, and it was doubtless still larger in the Pleistocene epoch. Its erosive work in the Grand Coulee and Quincy Valley, impressive though it is, appears to me about what would be expected from a stream of such size when diverted from its valley and poured for a long time over a surface of considerable relief that was wholly unadjusted to it. The dry falls in the Grand Coulee resemble Niagara Falls and are evidently the product of normal stream work. The deep gorge of the coulee below the dry falls was apparently excavated by the same orderly and long-continued process of head-end erosion as the gorge below Niagara Falls, and it could hardly have been produced in a short time by a flood of whatever magnitude. Quincy Valley, into which the waters of the Grand Coulee discharged, evidently became the scene of a lake in which sediments were deposited and which at first discharged westward into the valley of Columbia River, forming several cataracts that retreated some distance in normal fashion before they were abandoned. Later all the water was discharged through the present outlet, the lake was drained, and the stream cut into the sedimentary deposits in Quincy Valley to a depth of about 150 feet, forming a broad stream valley with a series of extensive terraces. All these were orderly and long-continued processes of erosion and sedimentation. The features of erosion and deposition are indeed very impressive, but they are, I believe, of a kind and size that would be expected from so large a river as the Columbia must have been in the Pleistocene epoch. The rock-cut terraces of the Columbia River Valley also indicate a succession of long periods of stream erosion. The short gorges below the cataracts that discharged the overflow of the lake in Quincy Valley open upon a stream terrace that stands 900 to 1,000 feet above sea level and 400 to 500 feet above the present river level. The floor of Moses Coulee is continuous with a terrace 800 to 900 feet above sea level and about 300 feet above the river. Though the evidence is perhaps not conclusive, it seems to me that the upper of these two terraces represents the floor of the

Columbia River Valley before the river was diverted to form the Grand Coulee and the lake in Quincy Valley, the lower terrace represents the floor of the Columbia River Valley at a later time when the Moses Coulee was cut, and the gorge below the lower terrace represents the later erosion work of the Columbia.

Having seen only this part of the region, in which I believe the existing features can be explained by assuming normal stream work of the ancient Columbia River, I am naturally loath to accept a theory of an abnormal flood for the scablands farther east. Before a theory that requires a seemingly impossible quantity of water is fully accepted, every effort should be made to account for the existing features without employing so violent an assumption. I suggest that full weight be given to the following considerations, all of which have, of course, already received careful study by Dr. Bretz: 1. The Pleistocene Columbia was necessarily a very large stream, especially in times of flood. 2. Its waters were diverted over country of considerable relief that was wholly unadjusted to it. 3. It is probably not necessary to assume that all of the region was channelled simultaneously. Is it not more probable that the water flowed successively over different tracts as the ice front changed? 4. Unless there is conclusive proof, it should not be assumed that along any drainage line the erosion work at high and low levels was done simultaneously. It would seem more probable that the work of erosion proceeded during a long time and that the high-level channels were abandoned as the stream cut down to lower levels. 5. Tilting and folding of the rocks have in this region occurred in recent geologic time, probably during and since the cutting of the Pleistocene channels. For example, there seems to be evidence that the upper terrace of the Columbia River Valley has been deformed This recent deformation may account to some extent for channels cut through ridges that can not otherwise be well explained except by assuming excessive depths of flood water.

J. T. PARDEE: Other things being equal, the amount of talus beneath a cliff would vary considerably according to whether the exposure faced toward or away from the sun Disruption of the rock due to temperature changes and alternate freezing and thawing of water would be most effective on southern exposures.

DR. BRETZ. *Reply to Mr. Gilluly:* There are old weathered gravels down in Snake River canyon both above and below the entrance of the scabland rivers, and much lower than the upper limit reached by the glacial waters in this canyon. The canyon therefore is older than the Spokane episode or any gravel deposits in the scablands, and a canyon at Wallula Gateway must have been there in pre-scabland time. I believe that the field evidence for this conclusion would convince any of my critics. Scabland and gravel up on the walls of the Gateway do not date back to the initiation of the canyon, and some sort of ponding must be provided. Without a ponding episode, the upper scabland must be older than the tributary canyons at the Gateway. But even the map shows how the glacial waters cut up the shoulders between the small tributary canyons already in existence. A pre-scabland floor of the Gateway about 200 feet above present river level is suggested by the hanging condition of Spring Gulch. Russell's speculations on ponding in the Columbia Valley dealt with the berg-carried erratics, not with scabland, and called for a valley glacier down in the gorge at or near The Dalles, or for a subsidence of the entire region. I have believed that this second suggestion is correct. There is a possibility that final solution of the scabland problem will tie this berg-drift into the scabland story. Jenkins did not suggest any disagreement with my bottle-neck hypothesis, though his article was avowedly a discussion of the ponding. There are certain to be differences in talus height because of local variations such as I have indicated in one of my papers. But where these differences are definitely traceable to local factors, such as variations in basaltic structures or spill of local runoff over the cliff or an active stream in the valley below or other conditions, it seems permissible to so treat them and yet to draw generalizations. The blocky material on the surface of talus in the scablands indicates a rate of growth in excess of the rate of disintegration into fine material. Bryan has indicated this in one of his papers on Pedestal Rocks. Comparison with sandstone cliffs is hardly trustworthy. It is much more likely that talus accumulations in the scablands have been added to, rather than diminished, by wind action. And in the empty channels I do not believe that removal of talus material by any process has occurred in appreciable amount in post-scabland times. Furthermore, the unfilled basins of the channeled scablands, existing even close to the upper limits of glacial waters in Wallula Gateway, have lingered overlong for a region whose talus has reached a profile of equilibrium I have not considered "equilibrium" attained until the talus covers the whole face of a cliff. A soil from disintegration of the basalt should cover a stable talus, and this is essentially lacking in the scablands or at the Gateway. The "jökullaup" sub-hypothesis I never have defended and never shall, until adequate field evidence from the required volcanic tract is forthcoming. But must it be dismissed because of Mr. Gilluly's computations? Are they conclusive? After indicating the untrustworthiness of figures, because of possible overlooked factors not represented in the computations, Gilluly moves into the very position I am scolded for taking. And the accounts of Icelandic jökullaup—are they merely early experiments in sensational journalism? Granting, however, that we must never again look toward subglacial vulcanism for a Spokane flood, must this close our minds to the flood hypothesis? I believe that my interpretation of channeled scabland should stand or fall on the scabland phenomena themselves. Perhaps, however, my attitude of dogmatic finality is proving contagious. I am glad to have convinced Mr. Gilluly that the scabland high up on the Gateway walls is stream work. I anticipated a skeptical attitude on even this point, for it is an extraordinary place for scabland, by any hypothesis for the great system on the plateau north of Snake River. The only known records for pre-Spokane ice on the plateau are about Spokane and Cheney where there is a weathered till beneath the Palouse loess. The whole record of glacial waters across the plateau and through the Gateway is post-loess! I do not yet share Gilluly's belief that pre-Spokane glacial waters are recorded in the Gateway, nor his confidence that the history can be diagnosed readily at long distance. Even a bed-side practitioner may err, I understand.

Reply to Mr. McKnight Undoubtedly the Columbia has undercut White Bluffs and thus shortened Koontz Coulee. But its eastward shift is not down the slope of a pre-Ringold basalt floor. The basalt is at least 100 feet below the river surface at Ringold, at the foot of White Bluffs. And Gable Mountain, a rugged eminence five miles long and at least 700 feet above the river, stands in the eastern half of the tract which the river, by this conception, has made by lateral planation. Jenkins thinks that the Ringold silt underlies the gravel of this wide part of the Columbia Valley. The 200-foot range in altitude of the gravel deposits about Gable Butte and Gable Mountain appears to be wholly in material of the same age. If the gravels of this part of Columbia Valley are normal affairs of valley or channel deepening, the older and higher portions should lie successively farther west from White Bluffs. But no succession of terraces of different ages has been found; instead, the relief appears to be a matter of great bars and abandoned channels with "holes" in them as low as present river level, all disposed with reference to the two basaltic interruptions as they should be if the entire valley at one time were a river bottom. While the main floor of Koontz Coulee hangs only 150 feet above the Columbia, three other glacial spillways, all within a mile and a half of the mouth of Koontz Coulee, hang 250 to 400 feet above, and all have approximately the same gradient. If their profiles are projected, they will reach at least twice as far out into Columbia Valley. By Mr. McKnight's explanation, there must have been as much lateral planation by the Columbia while the glacial waters were using Othello Channels as in all subsequent time. This projection of profiles assumes a Columbia River bottom, at about 500 feet A. T. at that time. How Othello Channels and its distributaries (Koontz, etc.) could have discharged across the Ringold flat at an upper limit of 1150+ while the Crab Creek syncline was undoubtedly an open route (for it also carried the glacial waters) to the capacious Columbia Valley is a puzzle for which I have found no answer save great volume and ponding at Wallula Gateway. If my information were limited to this district alone, I probably would not have arrived at present interpretations. It is in the remarkable interrelationships of the channeled scabland *ensemble* that the conception of a Spokane flood finds support.

Reply to Mr. Mansfield· I have had no success in fitting the field evidence to the idea of shifting dischargeways across the scablands. I cannot get the glacial streams to cross at Palouse Canyon, Devils Canyon, etc., without a ponding farther down the Columbia, nor to cut the canyons or canyon groups at these separated places without maintaining all dischargeways while the ponded condition is being removed. A labyrinthine group admittedly records a succession of events in that the glacial river was drawn down from original wide spreading as the canyons were eroded. But such cutting apparently must be done while the Wallula ponding was being lowered, or else that ponding must be repeated for each successive epoch of occupation. Only the Moses Coulee and Grand Coulee-Drumheller Channels plexus groups would have developed without the backing up postulated. Mr. Mansfield's idea of obtaining the rate of erosion of the basalt at The Dalles is excellent, but probably can be applied only to the features exposed at low water, and altered only during high water. The deeper and inaccessible parts of such a channel group should be the most rapidly changed. I hope that Mr. Mansfield and others of the United States Geological Survey will be able some time to study the channeled scablands in detail. These features should take their place in the literature as a group of land forms without parallel, and a genesis that can be agreed upon should be established.

Reply to Mr. Meinzer: The erosion of Grand Coulee could not have taken a longer time than the sum of whatever glacial stream occupation it has had. The margin of the ice sheet must have remained within 35 miles of its maximum advance in order to produce the Grand Coulee diversion. We may multiply whatever time interval this represents by different glaciations to get a longer period but it does not seem possible to consider this canyon a normal product of long-continued stream erosion. The scabland plexus east of Grand Coulee, from Coulee City south to the Quincy basin, is certainly not a normal affair, for three pre-existing valleys were entered and much eroded by glacial waters from the north before deepening of the lower coulee occurred sufficiently to contain the discharge. The lake sediments of Quincy Valley lie beneath thick basaltic gravel deposits which are disposed, as in so many other places in the channeled scablands, in great mounds, several miles long, with gentle back slopes and side slopes that are constructional profiles. These are separated by three wide channels of contemporaneous origin, leading from Crab Creek and Grand Coulee across the basin to Drumheller Channels. My earlier interpretations were that these channels (Moses Lake lies in one of them) were dissected out of a once-continuous gravel fill, but many features could not be harmonized with this, and I have been trying the Spokane Flood idea since. Several years ago Mr. Meinzer suggested to me that tilting or some other adequate cause had diverted discharge from The Potholes and Frenchman Springs cataract to Drumheller Channels, and I have tried since to apply this in the field. But I cannot find any evidence to support it. The rock terraces of Columbia Valley to which Mr. Meinzer refers were there in present development when the Flood occurred. The prominent one at the Potholes alcove rises northward along the Columbia about 300 feet in four miles. The surface of the southern part of it, below about 1250 A. T., is typical scabland and has a sharply defined cliff back of it. The northern part, above the level of the flood as indicated by upper limits in all three spillways out of Quincy basin, carries no such record and has no bare rock in the cliff back of it. Slope of the cliff and talus, which is soil covered to the very top, indicate a much older feature. As Professor Davis would say, the cliff in its southern part has been "refresht." This northward rise of the rock terrace is due to the warping in Babcock Ridge, a low anticlinal into which the Columbia has cut its valley. That rock terrace was here, in its present warped condition, I think, before the glacial discharge occurred The close approximation of upper flood limit on this terrace, in the two cataracts named and in Drumheller Channels seems to indicate that no warping comparable to what the terrace shows has occurred since the glacial flood. This is also the upper limit of scabland in Wallula Gateway. The upper limits in such widely spaced features as Othello Channels, Devils Canyon and Snake River Canyon do not vary more than 100 feet from 1250. There is, of course, no precise marker in the topography for upper limits, for most of these features are river-bottom forms, but I do not think my figures miss it by more than 100 feet. Such coincidence of altitudes as I have indicated is remarkable if different episodes are involved or if the region has been warped since Spokane time. Moses Coulee below Three Devils abandoned cataract has 200 feet or more of debris, mostly gravel, on the rock floor which therefore is as low as in Columbia Valley at the junction of the two valleys.

W. P. WOODRING, W. W. RUBEY, *Secretaries.*

SCIENTIFIC NOTES AND NEWS

The Washington section of the American Institute of Mining and Metallurgical Engineers met at the Geological Survey on March 25. D. F. HEWETT gave an illustrated talk on *Some impressions of European metal mines;* and a paper on *Mining practices in central Europe*, by M. VAN SICLEN, was read in the absence of the author. The work of American Engineering Council was discussed, and resolutions were passed recommending that either the Institute rejoin the council or authorize its constituent sections to do so.

In connection with the annual meeting of the American Geophysical Union there will be an exhibition of geophysical instruments, research problems, methods, and results at the National Academy and Research Building, from Friday, April 22 to Friday, April 29 inclusive, (except Sunday) between the hours 9 a.m and 5 p.m.

Erratum —On page 183 of the preceding number the sentence regarding a lecture for the public on climatic factors should be replaced by the following. In the program for general assembly on the afternoon of April 29, there will be a symposium and discussion on *Some factors of climatic control.*

The annual meeting of the American section of the International Union of scientific radiotelegraphy is to be held on April 21 at 10·30 a.m in the building of the National Research Council A number of papers on scientific radio subjects will be presented. The principal feature of the meeting will be the presentation of reports of the following technical committees: *Methods of measurement and standards*, J. H. DELLINGER; *Radio wave transmission phenomena*, L. W. AUSTIN; *Variations of radio wave direction*, G. BREIT; *Wave phenomena above 3000 kilocycles*, A. H. TAYLOR; *Atmospheric disturbances*, H. T. FRIIS.

Dr. F. C. BROWN has resigned as assistant director of the Bureau of Standards, to take charge of the organization of the recently established Museums of the Peaceful Arts, in New York City.

Dr N L. BOWEN of the Geophysical Laboratory, Carnegie Institution of Washington, has been delivering a series of lectures on petrology at Princeton University. The topics treated include fractional crystallization, the reaction principle, variation diagrams, liquid immiscibility in silicates, ultrabasic rocks, olioine basalts, and glassy rocks

RESOLUTIONS

The following resolutions on the death of Professor LEON PIÈRRE MANOUVRIER were adopted by the ACADEMY.

Whereas: On January 18 death overcame Professor LEON PIÈRRE MANOUVRIER, for several decades the Secretary and Professor of the Paris Ecole d'Anthropologie, Director of the Laboratoire d'Anthropologie de l'Ecole des Hautes Etudes, Sub-Director of the Physiological Laboratory of the Collège de France, and unquestionably the dean of Physical Anthropology in France.

And whereas· In MANOUVRIER French science and anthropology in general lose one of their foremost representatives, a man of great talent and one of unselfishness, with sterling honesty and character. Men of such qualities are born but rarely.

Resolved· The Washington Academy of Sciences expresses regret at the passing of its distinguished colleague and joins with his co-workers in France in paying tribute to his scientific achievements. The Academy also condoles with the members of Professor Manouvrier's family in their personal loss.

Resolved· That a copy of the resolution be sent to the Ecole d'Anthropologie de Paris and to Madame MANOUVRIER.

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BOTANY.—*Revision of the genus* Myrrhidendron.[1] JOHN M. COULTER, Boyce Thompson Institute, and J. N. ROSE, National Museum.

In 1894 we published, in the Botanical Gazette, the description of a very remarkable genus of Umbelliferae, from the high mountains of Costa Rica. This plant had been obtained by Capt. John Donnell Smith as one of the results of his energetic pioneer field work in Central America. Through his generosity we were able to accompany this description with a beautiful lithographic plate, made from a drawing by the late C. E. Faxon. Nothing more was learned of this genus until 1911, when Dr. William R. Maxon and Mr. Henry Pittier collected a similar plant high on the slopes of the volcano Chiriquí, in Panama. Again, in 1917, Dr. F. W. Pennell collected on the páramos of western Colombia a third species, which we have named in his honor. While studying this new plant from Colombia, we had occasion to re-examine Bentham's *Arracacia glaucescens*, and have reached the conclusion that this also should be referred to Myrrhidendron, thus raising the number of species to four.

KEY TO SPECIES

Leaflets more or less irregularly cleft or lobed . . **1. M. glaucescens**
Leaflets not lobed, or rarely some of them with 2 or 3 lobes.
  Rachis with a dense ring of short hairs at the base of the pinnae and leaflets **2. M. Pennellii**
  Rachis without a dense ring of short hairs at base of leaflets.
    Rays and pedicels glabrous . . . . . . **3. M. Maxonii**
    Rays and pedicels pubescent . . **4. M. Donnell-Smithii**

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[1] Received March 12, 1927

1. **Myrrhidendron glaucescens** (Bentham) Coulter & Rose

Arracacia glaucescens Bentham, Pl. Hartw. 187. 1845.

Herb, 1 meter high or more, stout, glabrous; basal and lower stems long petioled, with large vaginate stipular bases; blade ternate, then pinnate; ultimate segments strongly veined beneath, cleft, the lobes sharply serrate; umbel strongly petioled; involucel bracts several, more or less elongated, toothed; involucels narrow, entire or 3-toothed at apex; fruiting rays 15 to 20, about equal, 6 to 8 cm. long, somewhat hispid on the angles; pedicels 6 to 10 cm. long; fruit oblong, 8 to 10 mm. long, glabrous.

Type locality: "Hacienda de Iravi, prope pagum Perucho," Colombia.

We have not seen Hartweg's type of this species, but we have Purdie's specimen from Colombia collected in 1849 and F. W. Pennell's plant from the forests near the edge of the Páramo de Ruiz, in the Quindío, altitude 3,200 to 3,500 meters (no. 2997), and the plant of J. Triana from the forest of Quindío, altitude 2,600 meters, collected 1851 to 1857 (in the Columbia College Herbarium).

2. **Myrrhidendron Pennellii** Coulter & Rose, sp. nov.

Herb, caulescent, perhaps a meter high or more, glaucous, glabrous except the top of the stem and inflorescence; basal and lower leaves unknown; petioles of upper leaves broadly stipular; rachis glabrous except at the base of the pinnae and leaflets, here bearing a conspicuous ring of hairs; blade ternate, then pinnate, leaflets lanceolate, acuminate, 2 to 5 cm. long, sharply serrate, glabrous on both sides; peduncle 1 to 2 cm. long, more or less mealy-pubescent, tending to become glabrate below, involucre none; involucel bractlets conspicuous, sometimes entire but usually strongly lacerate at the apex; rays numerous, nearly equal, 4 to 6 cm long, pubescent; pedicels 8 to 10 mm. long; fruit oblong.

Type in the U. S. National Herbarium, no 1,042,584, collected near the Páramo de Ruiz in the Quindío, Colombia, altitude 2,600 to 2,800 meters, December 15 to 17, 1917 by F. W. Pennell (no. 2993). Also collected near Quindío Pass, August 2, 1922, by Killip and Hazen (nos. 9166 and 9452) at altitudes of 3,200 to 3,500 meters.

3. **Myrrhidendron Maxonii** Coulter & Rose, sp. nov.

A slender shrub, 3 to 4 m. high, crowned by a rosette of leaves, 3 to 4 dm. long, 3 to 4 times ternately compound; stipular sheaths of the petiole not greatly enlarged, about half the length of the petiole itself; leaflets lanceolate, acuminate, sharply serrate, the teeth bristle-tipped, umbel many-rayed; rays 5 to 10 cm. long; pedicels 1 to 1.5 cm. long; involucre usually a single large bract; involucel bractlets several, laciniately cleft toward the apex; fruit narrow, 2 cm. long.

Type in the U. S. National Herbarium, no. 675,668, collected on Cuesta Grande, eastern slope of Chiriquí Volcano, Panama, altitude 2,000 to 2,990 meters, March 11 to 13, 1911, by William R. Maxon (no. 5311). Collected also at the same place and time by H. Pittier (no. 3099).

4. **Myrrhidendron Donnell-Smithii** Coulter & Rose, Bot. Gaz. 19: 466. 1894.

A small tree, 3.6 to 4.8 m. high; trunk 7.5 cm in diameter; leaves large, 30 cm. or more long, ternately compound; leaflets ovate to lanceolate, 2.5 to 5 cm. long, acute, sharply and often irregularly serrate, the teeth more or less mucronate-tipped, glabrous, shining and impressed-veiny above, dull and paler beneath and conspicuously reticulate, petiolules with a prominent stipular ring which is more or less glandular-tufted; petioles large, inflated, peduncles short; involucre few-leaved; involucels numerous, 3 or 4-toothed or cleft near the apex, scarious-margined and strongly purplish-veined, inflorescence more or less glandular-puberulent, rays numerous, rarely equal; pedicels 8 to 10 mm. long; fruit linear, 10 to 12 mm. long, glabrous.

Type locality: Lava beds at the summit of the Volcano Irazú, Costa Rica

Besides the type specimen this plant has been collected in Costa Rica on the Volcán de Turrialba, 1924, by Paul C. Standley (no. 35056), and in 1899 by H. Pittier (no. 13214); on the Volcán Poás, 1924, by Paul C. Standley (no. 348681), and, 1890, by H. Pittier (no 2012), and on Cerro de las Vueltas, 1925-26, by Paul C Standley (no. 43970).

BOTANY.—*Two new grasses from South America.*[1] A. S. Hitchcock, Bureau of Plant Industry.

Recently a package of grasses was received from the Museu Nacional do Rio de Janeiro, Brazil, which included many interesting specimens. Among them was an undescribed species of *Olyra* which I take pleasure in naming for the Director of the Museum, Dr. Alberto José de Sampaio, who sent me the specimens and who collected most of them, though this interesting species of *Olyra* was collected by José Vidal.

The new species, described below, differs conspicuously from all other species of *Olyra* in the condensed inflorescence and the villous-ciliate spikelets.

Olyra Sampaiana Hitchc., sp. nov.

Plant perennial, culm erect, retrorsely scaberulous, pubescent below the panicle, about 35 cm tall, naked below, the sheaths bladeless, bearing two foliage leaves above, the nodes appressed-pubescent, sheaths slightly retrorsely scaberulous, ciliate on the overlapping margin, 6 to 7 cm. long, ligule 1 to 2 mm. long, truncate; blades thin, oblong-lanceolate, abruptly rounded below into a short puberulent petiole about 2 mm. long, gradually narrowed to an acuminate apex, glabrous on the upper surface, antrorsely scabrous beneath, 13 to 15 cm. long, 4.5 to 5 cm. wide, the principal nerves about 5 pairs; panicle condensed, oblong, 6 cm. long, 1 cm. wide, staminate

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[1] Received March 15, 1927.

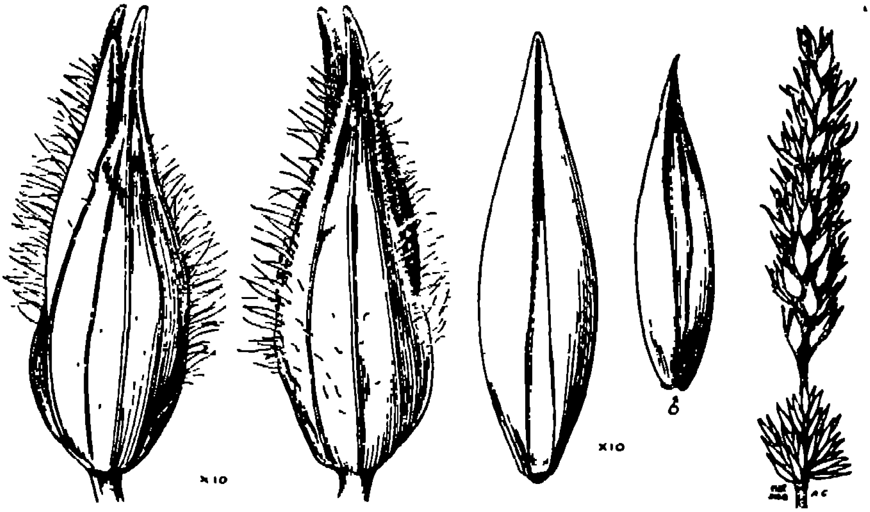

Fig. 1.—*Olyra Sampaiana*, 2 views of pistillate spikelet, fruit, and staminate spikelet, × 10 dia.; panicle, nat. size.

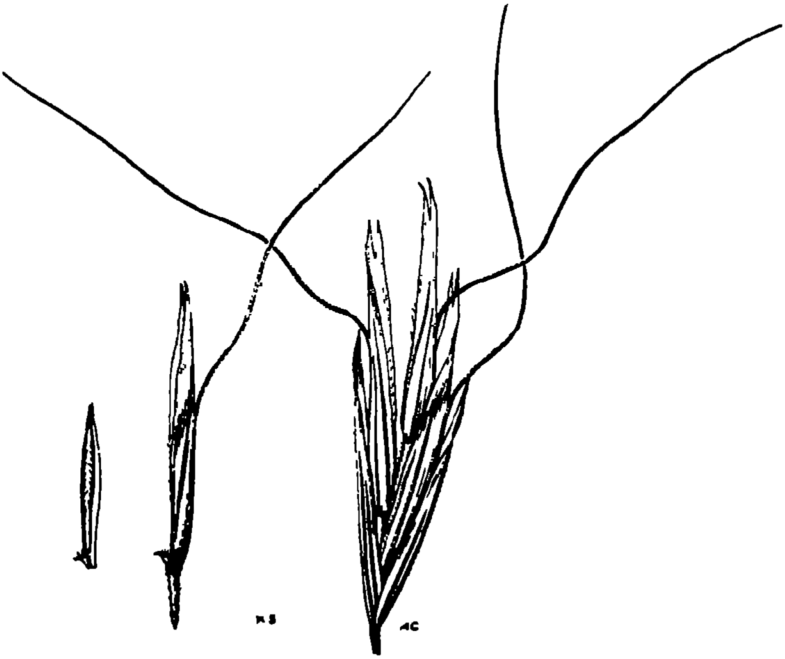

Fig. 2.—*Trisetum bulbosum*, spikelet, floret, and palea, × 5 dia.

below, pistillate above, interrupted between, the staminate portion about 1 cm. long; staminate spikelets narrow, about 4 mm. long, acuminate; pistillate spikelets about 2.5 mm wide, the glume and sterile lemma about equal, 7 mm long, tawny, rather thick and firm, 5-nerved, the outer nerves forming a thickened margin, the glume minutely pubescent, with a conspicuous fringe of hairs near the margin and somewhat short-villous on the back below, the sterile lemma similar but less villous and with scant marginal hairs; fruit narrow, 6 mm. long, 1.7 mm wide, acuminate, with a blunt tip, laterally compressed at base, glabrous, dull white or tawny, under a lens very obscurely pitted, the margins nearly meeting over the palea along the upper part.

Type in the United States National Herbarium, no. 1,297,351, collected at Reeve, State of Espirito Santo, Brazil, December 6, 1924, by José Vidal (no. 44). I have seen no other specimen.

The Grass Herbarium recently received a package of Chilean grasses from Brother Claude Joseph who has sent many plants from Chile to the United States National Herbarium. In this package was the specimen of *Trisetum* which is described below as a new species.

Trisetum bulbosum Hitchc , sp nov.

Perennial; culms erect, glabrous, 30 to 50 cm. tall, the base thickened to a bulb 3 to 6 mm. thick; sheaths glabrous, ligule thin, rounded and lacerate, 1 to 2 mm. long, decurrent; blades glabrous, scaberulous, flat, becoming somewhat involute or folded, mostly not more than 5 cm. long, the 4 to 6 cauline ones gradually shorter, 0 5 to 1 5 mm wide; panicle narrow, almost spikelike, 8 to 10 cm. long, pale, the branches appressed, the axis and branches scabrous; spikelets narrow, about 1 cm. long, mostly 3-flowered, the rachilla prolonged as a small bristle, the third floret smaller than the others, glumes narrow, the first 6 to 7 mm. long, 1 to 3-nerved, the second a little wider and a little longer (about 1 mm.) than the first, 3 to 5-nerved, first lemma narrow, about 1 cm. long, rather obscurely 3-nerved, minutely scaberulous below, the callus antrorsely pubescent, 0.5 mm. long (being the first rachilla-joint disarticulating at the base), the upper half scarious, the apex divided into two delicate pointed teeth 1 mm long, the awn emitted from about the middle of the back, 12 to 15 mm. long, geniculate, flexuous, palea small and narrow, about half as long as the lemma, finely ciliate on the nerves, second lemma similar to the first but a little smaller, the callus slender, sharp-pointed, about 2 mm. long, antrorsely pilose (consisting of the second joint of the rachilla disarticulating near the base), the short pilose base of the next rachilla joint remaining behind the palea; anthers 2 mm. long.

Type in the United States National Herbarium, no 1,297,352, collected at Concepción (San Pedro), Chile, October 30, 1926, by Brother Claude Joseph (no. 4607). I have seen no other specimen.

This species is easily distinguished by the small bulbs at the base of the culm. It differs from other species of *Trisetum* in the disarticulation of the rachilla. Usually, in this and allied genera, the rachilla disarticulates at the summit of the joint or internode thus leaving only a short callus at the base of the floret, the rachilla-joint above being persistent along the back of the palea. In *Trisetum bulbosum* the disarticulation takes place at the base of the joint, leaving the joint above as a long sharp callus projecting below the floret.

BOTANY.—*New genera and species of Ivory Palms from Colombia, Ecuador and Peru.*[1] O. F. Cook, Bureau of Plant Industry.

The "vegetable ivory" palms of South America are a neglected and little known group, peculiar in many floral characters as well as in the large size and solid texture of the endosperm. Eminent botanical authorities of the last century did not recognize *Phytelephas* as a true palm, but associated it with *Cyclanthus*, *Pandanus* or *Nipa*, or set it apart as an "anomalous genus." The relations with other American palms were not appreciated.[2]

The ivory palms are notably tolerant of shade and are adapted to undergrowth conditions of the darkest and dampest forests, but can live in the open if provided with sufficient moisture. Although the nuts are exported in large quantities from Ecuador, Colombia, and Panama, the palms are confined to the virgin forests which generally are remote from inhabited places and difficult of access, so that little botanical material has been collected and knowledge of the plant characters has remained fragmentary. Hundreds of sheets of other palms accumulated in the U. S. National Herbarium, but *Phytelephas* was represented only by a few fruits and nuts until leaves and inflorescences were collected in Panama by H. Pittier, a few years ago.

Thus far only the genus *Phytelephas* has been recognized in the ivory palm group, extending from Panama to Bolivia and including several species. A new genus from the west coast of Colombia has characters very different from *Phytelephas*, and is not less divergent from other palms. Two other genera need to be separated from *Phytelephas*, one in Peru and another in Ecuador.

Outstanding features of the new type from Colombia are a ramose male inflorescence and an expansion of the receptacles of the male flowers into large bodies, capitate and variously deformed by pressure, instead of the simple inflorescence and flat patelliform receptacles of *Phytelephas*. The stamens are minute and have the appearance of small grains of sand scattered over the surface of the receptacles, thus suggesting the generic name *Ammandra*. The filaments and anthers are very short, in contrast with the very long filaments and anthers of *Phytelephas*. The male inflorescence as a whole, forming a relatively short, closely ramified cluster of receptacles, suggests a sponge, a coral or a fungus, rather than a floral structure.

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[1] Received March 16, 1927

[2] Cook, O F, *Relationships of the Ivory Palms*, Contr U S Nat Herb 13: 133. 1910 *Ivory Palms in Panama*, This Journal 3: 138 1913 *Relationships of the False Date Palm of the Florida Keys, with a Synoptical Key to the American Families of Palms.* Contr. U S Nat. Herb. 16: 243. 1913

The plant has no trunk, but forms a circle of leaves on long slender leaf-sheaths and petioles, like a tall, graceful fern. The sheaths and petioles are nearly erect and the leaf-blades ascending, though the outer leaves become more divergent, with the pinnae horizontal or eventually somewhat drooping. The reduction of the terminal pinnae is carried further than usual, the last pinnae being only a few centimeters long. The lower pinnae are widely spaced and very narrow, but not shorter than those above. The total length of the leaf, from the base of the sheath to the tip of the blade, is more than 6 meters. The leaf-sheath bundle holds a mass of fibers and fallen leaves that conceal the inflorescences, so that the general appearance of the plants is not altered at the fruiting stage.

The leaves are very different from those of *Phytelephas* in having very long sheaths and petioles, the margins of the sheaths resolved into long simple fibers. The prolonged upper portion of the sheath is shaped like the petiole, nearly round in cross-section. In *Phytelephas* the leaf-sheaths are relatively short and the petiole lacking or very short, that is, with no interval of naked stalk between the sheath and the lowest pinnae. An elongate petiole has been reported by Spruce in a species of *Phytelephas* from eastern Peru, but with trunk and fruit characters which show that it is different from *Ammandra* as well as from *Phytelephas*. Contrasting characters of the four genera now recognized are stated in the following analytical key.

ANALYTICAL KEY TO GENERA OF PHYTELEPHANTACEAE

Palms with slender trunks and few leaves; fruits with a fleshy rind and a soft edible pulp. Genus **Yarina,** type species *Yarina microcarpa* (Ruiz and Pavon), from eastern Peru.

Palms with stout trunks or rootstocks and numerous large leaves 6 to 8 meters long, fruits with a hard shell armed with large woody spines and lined with stiff fibers . . . .

Male flowers represented by large capitate-angular receptacles rather sparingly beset with minute stamens, the anthers and filaments both very short; leaves with long slender sheaths and petioles: Genus **Ammandra,** type species *Ammandra decasperma* Cook, from Colombia.

Male flowers with flat patelliform receptacles closely crowded with the filaments of the large stamens, the anthers and filaments both very long; leaves with short sheaths; petioles very short or wanting . . . .

Male flowers sessile or on very short pedicels, forming a continuous covering of the spadix; stamens 36 to about 200, in a close tuft or tassel; leaves with pinnae regularly spaced along the rachis: Genus **Phytelephas,** type species *Phytelephas macrocarpa* Ruiz and Pavon, from eastern Peru.

Male flowers on slender tapering pedicels 4 to 6 cm. long; stamens more than 1,000 forming large spherical heads 2 to 3 cm. in diameter; leaves with pinnae aggregated in groups: Genus **Palandra**, type species *Palandra aequatorialis* (Spruce), from Ecuador.

Ammandra Cook, new genus

Palms related to *Phytelephas*, with large spiny fruits in dense heads, but the male inflorescence short and ramose, and the male flowers represented by angular woody receptacles with very small, short stamens scattered over the surface Plants trunkless, with slender pinnate leaves on long cylindrical petioles, the leaf-sheaths resolved, except on the petiole side, into a loose network of long slender straight fibers like horse-hairs; pinnae less than 50, mostly opposite, regularly spaced, the terminal and subterminal much reduced, texture thin and papery, smooth on both surfaces, below with prominent submarginal veins. Male inflorescence with two spathes, the outer short, ensiform, the inner complete, fusiform or ovate, of rather thin texture, with narrow lateral carinae Peduncle rather slender, somewhat compressed. with several large bracts below the flowering portion; axis strongly flattened with numerous short branches forming clusters of oblong, cylindrical or irregularly compressed woody receptacles representing the male flowers; stamens very small with short oblong anthers borne on very short filaments so that the anthers appear sessile on the surface of the receptacles Female inflorescence and fruits similar to those of *Phytelephas*, rough with pyramidal spines, but with fewer fruits in a cluster, larger numbers of seeds in the fruits, the seeds strongly compressed, the hilum at the base of the seed, instead of on the inner or mesial face as in *Phytelephas*, the endocarp and testa thinner, the endosperm grooved by the branches of the raphe, the embryo short and broad, subdorsal, remote from the hilum

Ammandra decasperma Cook, new species

A trunkless palm with an extremely short axis, the insertions of the leaves not separated by any lengthening of the internodes, also the leaf-bases extremely thin and closely compressed at the ring of attachment. Leaves about 10 or 12, attaining a length of 6 meters, with long slender sheaths and petioles, a relatively short rachis, and less than 50 pairs of pinnae, usually opposite, with remarkably exact placement

Leaf-sheaths attaining 120 cm , measured to the ends of the vertical grooves marking the attachment of the fibers, the sheath-tissues remaining alive only on the petiole side, not persisting in the form of plates or sheets of dry material, but soon resolved into slender straight fibers, with very slight connection into a network, base of sheath of indurated texture, only 2 or 3 mm. thick at the attachment to the axis, the surface a peculiar gray-drab color, becoming greenish about 60 cm. above the base; living portion of sheath at 20 cm from the base 4 cm. wide and about 2 5 cm. thick, retaining this thickness upward; inner face of sheath concave or flat for about 90 cm. from base, then becoming convex, upper part of the sheath like the petiole in color, texture and shape, becoming nearly round and merging gradually into the petiole, marked on the inner face by the narrow lines of attachment of the fibers, about 1 cm apart; cut surfaces of sheath and petiole showing scattered dark brown or black fibers Petioles erect, attaining 3 meters, about 2 cm. wide at base, nearly cylindrical, slightly thicker than wide. Rachis 259 to 264 cm. long, blade 269 cm long; rachis sharply angled above, flat underneath, triangular in section. Pinnae 45 to 47 on each side, the lowest very narrow, the middle lanceolate; the terminal very short; texture rather thin, smooth and naked on both sides, somewhat paler beneath, with strong submarginal veins 2 to 4 mm. from the margin, prominent below and forming a sharp ridge firmer than the margin; two other large veins between the submarginal and the midrib, but not prominent; lowest pinna on one side of leaf 40 cm. by 3 mm., on other side 49 5 by 8 mm.; second and third pinnae respectively 63 cm. by 2 cm and 64 cm. by 3 5 cm , pinna from middle of leaf 60 cm by 5 3 cm., tenth pinna from the end 37 cm by 2 6 cm ; subterminal pinna 16 cm by 1 5 cm ; terminal 11 cm. by 1 cm ; or the narrowly margined percurrent rachis may be considered as a terminal pinna, 9 cm long by 3 mm. wide.

Male inflorescence: outer spathe, incomplete, 4.5 cm wide at 10 cm. from the end, the terminal portion ensiform, flattened, carinate, splitting about 6 cm from the end on each side; texture very firm and tough, the surface gray-drab like the base of the leaf-sheaths; inner spathe 37 cm long, 3 cm wide at base, widened gradually to 4 cm and then more abruptly, about 6 cm wide at 10 cm from the end, splitting for about 20 cm ; a distinct narrow carina on each side, the texture thin, rather stiff and papery when dry, the surface even, not plicate or fissured as in *Attalea.* Peduncle with 5 large bracts or rudimentary spathes below the first flowers; length of peduncle to first bract 35 cm , to first flower 49 cm , the first bract 5 cm. long, the others shorter; peduncle 2 5 cm wide at base, 1 8 cm. thick Flowering axis about 30 cm. long strongly compressed, 3 cm wide, 1 cm or less in thickness, with the heads of flowers forming a dense mass 8 to 10 cm wide, gradually tapering to the end, some of the lower flower clusters 2 to 3 cm apart, the others more compact, the heads of flowers with pedicels 1 to 2 cm long, the heads 3 cm. long including the pedicels, and 3 cm broad, each head composed of 6 to 9 broadly angular or variously compressed individual receptacles 1 to 1.5 cm. long and wide, often with distinct stalks 5 mm. long and wide; the heads rusty brown in color with pale yellowish stamens sprinkled rather sparsely over the surface, the individual stamens usually well separated, seldom in contact

Female inflorescence seen only in fruiting stage, about 20 cm long, with the fruits 30 cm , at base 2 5 cm wide; basal joint 1 5 cm long, to insertion of first spathe, notched at the sides, spathe 18 cm long, 3 cm wide, ensiform with a rather broad tip, open on one side for about half the length; lateral carinae thin, about 5 mm. wide, second joint of spadix about 8 cm long, second spathe 15 cm. long, about 4 cm wide, the lateral carinae reduced to fine ridges; peduncle between upper spathe and fruit head 6 to 8 cm long, 2 5 cm wide at base, 4 cm at end, 2 cm thick in upper part, the surface smooth, not marked with bract-scars, but close to the end showing two complete rings of united bases of bracts or small spathes; fruits subtended by a bract about 2 cm wide and by a persistent perianth; sepals 4, petals 5 or 6, the petals somewhat narrower than the sepals, 6 to 7 mm. wide, probably about 5 cm long Fruit-cluster smaller than in *Phytelephas*, the 3 to 5 fruits 9 cm to 13 cm. in diameter, armed with coarse woody spines and persistent woody styles 1 to 3 cm. long; exocarp fibers short and close, mesocarp fibers fine and rather sparse; with a thin tight-fitting, fibrous sac of tough flexible texture inclosing each seed; such sacs not present or only slightly indicated in *Phytelephas.* Seeds 7 to 10, strongly compressed and flat-sided, 4.5 to 5 cm. long, 3 to 4 cm. broad, 2.2 to 3 cm. thick, often narrowly wedge-shaped or flattened, the inner margin nearly straight, with a sharp or somewhat prominent lower corner, at the adhilum; surface of seeds smooth and even, black, without the layer of closely adherent whitish material surrounding the seeds of *Phytelephas;* hilum basal, rather large and prominent, attaining 2 cm. by nearly 1.5 cm., coarsely pitted, but with outer coat of hard, brittle, dark brown tissue.

The type specimens, with male and female inflorescences, were collected at Buenaventura Colombia by O. F. Cook and F. C. Baker (no. 153) May 26, 1926, and have been deposited in the U. S. National Herbarium, under numbers 1,282,066, 1,282,067, 1,282,068, 1,282,069, 1,282,070, 1,282,071.

Buenaventura is noted for its heavy and nearly continuous rainfall. The surrounding country is a network of tidal inlets, swamps, and small hilly islands, often with steep or precipitous shores, scoured by strong tidal currents *Ammandra* grows in abundance on the wooded islets across the river from the town Like other ivory palms, it is an undergrowth plant of the deep forests.

A port has been constructed at Buenaventura and a railroad to the interior, but in many places the forests have not been cut, and the palm flora is still intact. Of 13 groups of American palms that have been recognized as families, at least 9 are represented at Buenaventura, only the Ceroxylaceae, Pseudophoenicaceae, Malortieaceae, and Chamaedoreaceae being absent. Among the genera represented are *Bactris, Attalea, Scheelea, Guilielma, Manicaria, Geonoma, Welfia, Oenocarpus, Catostigma, Synechanthus, Mauritia,* and *Acanthorhiza.* Several genera, such as *Astrocaryum, Acrocomia, Pyrenoglyphis, Elaeis,* and *Raphia,* which occur on the Isthmus of Panama were not seen at Buenaventura.

Two other trunkless palms, an *Attalea* and a *Scheelea,* grow in the same forests, but *Ammandra* has smaller and more slender leaves, with no tendency to grouping of the pinnae or to adherence of the upper pinnae to form a solid terminal section of the leaf, which are features of the cocoid genera Special leaf characters of *Ammandra* are the strong submarginal veins of the pinnae and the great reduction of the terminal pinnae Most of the pinnae are arranged in opposite pairs, especially in the middle and upper part of the leaf, but the narrow lower pinnae may be alternate or somewhat irregular

The flowering season of *Ammandra* probably occurs in December At the end of May it appeared that no flowers or fruits were obtainable, though hundreds of individuals were examined in the hope of identifying the strange palm. Finally, at the close of our last visit to the forest, two fruiting individuals were found and a single male inflorescence was brought in by our native guide. Further search was forbidden by the danger of being stranded above the tangled passages of a narrow tidal creek.

While the inflorescence was drying on board the steamer, many beetles emerged. Specimens have been deposited in the U. S. National Museum, including two species of weevils, a Scarabeid, a Hydrophilid, and six species of Staphylinidae

The native name of the Ammandra palm at Buenaventura is "*cabecita,*" meaning "little head," doubtless with reference to the smaller size of the fruit clusters, in comparison with *Phytelephas.* The nuts are not collected or exported, being smaller in size and the endosperm possibly not so hard as in *Phytelephas*, which apparently does not occur in the immediate vicinity of Buenaventura. According to local information the nearest locality for the true "tagua" is on the Dagua River several hours by canoe from Buenaventura.

Yarina Cook, new genus

Ivory palms from eastern Peru with petiolate leaves as in *Ammandra*, but borne on a slender ascending trunk marked with deep areolate leaf-scars arranged in spirals The leaves are few and the petioles shorter than in *Ammandra*, the pinnae more numerous and shorter, and the lower pinnae much reduced The fruits are fleshy and edible, including the outer rind, which in *Ammandra* and *Phytelephas* forms a hard shell armed with large woody spines and with an inner lining of stiff fibers.

The only ivory palm previously described with petiolate leaves is a species that grows in the eastern Andes of Peru, named by Ruiz and Pavon in 1798, though still but little known The presence of a petiole suggests an association with *Ammandra*, but an assignment to that genus is not warranted in view of several differences recorded by Spruce and shown in the photograph included by Wallace in Spruce's "Notes of a Botanist on the Amazon and Andes."

Yarina microcarpa (Ruiz and Pavon) Cook

Phytelephas microcarpa Ruiz and Pavon, Syst Veg. Peruv. **1**: 302. 1798. SPRUCE, Journ. Proc. Linn Soc. Bot. **11**: 176. 1871. Notes of a Botanist on the Amazon and Andes, **2**: 133, *f 6*. 1908.

The photograph is said to have been taken on the river Ucayali in eastern Peru and shows a small slender palm with only 6 or 7 leaves, the pinnae widely spaced and spreading, horizontal in the middle of the leaf, retrorse in the lower part, and apparently with much shorter petioles and sheaths than in *Ammandra*. The lower pinnae are much shorter, and go down nearly to the point of divergence of the leaf bases, so that the petioles may not be more than one or two feet long, instead of 7 or 8 feet as in *Ammandra*. The number of pinnae probably is between 60 and 70. The characters of the inflorescences and flowers are still entirely unknown, and should receive the attention of botanists who visit the eastern Andes

Spruce saw the palm in many places along the Huallaga River, and the original localities mentioned by Ruiz and Pavon were between the Ucayali and the Huallaga. The type species of *Phytelephas*, *P macrocarpa*, also grows in the same region and is described by Spruce as having "no proper petiole at all," in comparison with a "long petiole" in *P microcarpa*. The trunk and fruit characters are also definitely contrasted, *P. macrocarpa* with "either no trunk at all, or a very short and stout one, which is nearly always inclined or crooked," while in *P. microcarpa* "well-grown plants have a slender inclined stem no thicker than the arm, reaching 10 feet high, and spirally areolate with the deep leaf-scars. The fruits are about the size of a child's head, and so much resemble externally the fruits of some anonas, that the Peruvians call them 'Anon de Palma,' but the palm itself it called 'Yarina.'" The fruits of *P macrocarpa* "are 9 to 12 inches in diameter, nearly spherical, and consist of from 12 to 20 closely packed capitula. . . . ."

The native name *yarina* affords a convenient generic designation. As a word of the Quichua language *yarina*, or *yaurina*, is supposed to mean fish-hook or fish-bait, and may allude to a use of the hard nuts to make fish-hooks Also the edible fruit pulp might be used as bait, or in catching fish with poison

Genus PHYTELEPHAS Ruiz and Pavon

Ivory palms with stout trunks, usually short and decumbent, but in some species ascending or erect, with very short internodes. Leaves numerous and large, pinnae 80 to 100 pairs equally spaced on the rachis, with little or no petiole, male inflorescence emerging from the two spathes as a long simple spike or catkin densely crowded with sessile or subsessile male flowers, each flower a compact tassel-like cluster of large stamens, both filaments and anthers long and slender; female inflorescence very short, the cluster of large female flowers surrounded by an involucre of large bracts, fruits very large and woody, with 4 to 7 large triangular wedge-shaped nuts, and hilum near the middle of the inner angle of the nut, the embryo basal, narrower and longer than in *Ammandra*

The type species is *Phytelephas macrocarpa* Ruiz and Pavon, from eastern Peru Characters of this species as reported by Spruce are noted under *Yarina microcarpa*, *Phytelephas Seemanni*, and *P. karsteni*

Phytelephas tumacana Cook, new species

Trunk erect attaining 6 meters or more, 20 cm in diameter, with very short internodes, the angles of the leaf-bases persistent, forming close spirals; similar to the trunk of *Manicaria* but the internodes still shorter Leaves attaining 6 to 7 meters on young palms, on mature individuals about 5 meters; petioles short, 2 to 10 cm long, 4.5 cm wide, 2 5 cm. thick, rachis 5 meters, long, triangular in cross section with a broad, low, gradually sloping median ridge, the under surface deep green, mottled with grayish-brown scale material, very closely appressed Pinnae about 100 on each side, 102 counted; first pinna 12 cm by 1 cm , sometimes only 4 or 5 cm long, second and third pinnae scarcely larger than first, fifth pinna 19 cm by 1 5 cm., tenth pinna 28 cm by 2 cm with rachis 2 5 wide, middle pinnae attaining 94 cm. by 5 5 cm.; tenth pinna from the end 54 cm by 3 5 cm , fifth from end 43.5 cm by 3 cm , subterminal pinnae 44 cm by 1.5 cm.; terminal pinnae 20 by 1 5, sometimes symmetrical, with the percurrent rachis as midrib, but other leaves with a terminal split; midrib of pinnae prominent above and below; other veins prominent below but not above.

Male inflorescence· Outer spathe exposed 23 cm above ground, 5 5 cm. wide, including thin lateral carinae 6 to 7 mm wide, inner spathe 37 cm. long, probably about 5 cm wide, in dry state 4 cm between the carinae, which are much smaller than those of the outer spathe, peduncle from spathe to first flower 11 to 12 cm , the spathe decurrent on the sides, higher in the middle; flowering axis 50 cm. long, but probably not fully extended, the terminal portion with the flowers still very crowded, width of axis in the lower part 2.5 cm., with the flower masses 4 cm.; axis near the middle 2 cm. wide and 1 cm. thick, distinctly compressed, lowest bract 2 cm long, subtending 3 flowers in a group; other bracts gradually reduced, V-shaped, with a short narrow rim running up on each side of the cluster; the lower groups of flowers with separate pedicels 3 to 4 mm. long, 2 mm. wide; pedicels farther up irregular, united and reduced in length, the number irregular and difficult to determine, but many of the groups with four flowers and some with five; upper pedicels reduced to about 1 mm., in some cases all the flowers of a cluster seem to be completely fused, forming larger heads with dense masses of stamens 1.5 cm. long, or nearly 2 cm. long on some of the lower and more mature flowers. Stamens with brown filaments, becoming rather tough and elastic while drying, the anthers light yellow when fresh. Sepals and petals apparently represented by several small scale-like organs along the upper margins of the pedicels.

Female inflorescence seen only in fruiting stage; peduncle between the upper spathe scar and the fruit head 14 cm. long, 3.5 cm. wide, 2 cm. thick, marked in the upper half by numerous transverse or oblique bract-scars, 2 to 4 cm. wide, becoming closer and broader above, forming 2 or 3 complete collars at the end. Fruit cluster round, about 25 cm. in diameter, of 11 to 12 fruits, fitted compactly together, the fruits 10 cm. long, 14 cm. broad, with 4 to 6 nuts in each fruit, the normal number apparently 6, the fruits with 4 and 5 nuts appearing abnormal and unsymmetrical. Attachment of fruits 2.5 to 3 cm. long, 1.5 cm. wide, leaving a prominent rounded receptacle beset with short fibers; persistent styles and stigmas of fruits 13 cm. long, united for about half the length, then with branches separating rather irregularly, usually six, probably indicating the number of carpels, the tube of the style usually open on one side showing 12 longitudinal ridges or fibers, each pair of fibers probably representing a division of the stigma; texture of the persistent styles, stigmas and petals tough and horny, becoming brittle with age.

Specimens and photographs were obtained from palms growing at Tumaco, Colombia, some in a park and others in door-yards, said to be grown from seeds or plants brought from the adjacent mainland. The specimens and measurements of the leaves were from a large female palm with a trunk about 3 meters high bearing many large clusters of fruits. Type material is deposited in the U. S. National Herbarium under numbers 1,282,072, 1,282,073, 1,282,074, 1,282,075, 1,282,076, 1,282,077, collected at Tumaco, Colombia, May 10, 1926, by O. F. Cook and F. C. Baker (no. 103).

The leaves of *Phytelephas* are used extensively at Tumaco for thatching houses. The thatch material is called *cade*, while the nuts are called *tagua*. Spruce gives *cadi* as the name of *Phytelephas aequatorialis* in Ecuador. No doubt *cade* or *cadi* are equivalents of *kata*, which is a word for roof in the Quichua language of Peru, with *katani* and *katakuni* as verbs meaning to thatch. The wide distribution of Quichua plant names and place names in South America is remarkable. The word *tagua* or *tahua* in Quichua is the numeral four and may allude to the four nuts in each fruit, in the Peruvian species of *Phytelephas*. The name *polo ponto* or *pulu puntu*, recorded by Spruce for *Phytelephas macrocarpa* in the Eastern Andes, may be equivalent to *puillu puitu*, (Middendorff 665), meaning in Quichua a square of four-parted knot, that would aptly describe the fruit. The word *anta*, recorded by Seemann as the native name of *Phytelephas* in the Cupica district in the northwestern part of Colombia, means *metal* or *copper* in Quichua, and might refer to the hardness of the seeds. Also the word *chili* is given (Holguin 83) as the name of the "tree that produces the vegetable ivory (corozo)."

The young male inflorescences are eaten at Tumaco, as soon as they begin to emerge from the spathe, when a rapid growth or expansion is taking place and the tissues are still soft. During the process of drying the surfaces of the peduncle and axis have a moist appearance like cured vanilla beans, as though an oily substance were being formed by fermentation. There is a strong and rather pungent odor, not unpleasant, suggesting bitter almonds.

PHYTELEPHAS SEEMANNI Cook

Phytelephas macrocarpa Seemann, Botany of the Herald, 205, pl. 45–47. 1852–57. Not *Phytelephas macrocarpa* Ruiz and Pavon Syst Veg Peruv. **1**: 301. 1798 *Phytelephas seemanni* Cook, U. S Dept. Agric. Bur Pl. Ind. Bull. **242**: 68. 1912

"As already recognized by Spruce as far back as 1869, the name *Phytelephas macrocarpa* does not belong to the vegetable-ivory palm described by Seemann from Panama (Botany of the *Herald*, 1852–1857, pls. 45–47, p. 205). Two species, *macrocarpa* and *microcarpa*, both from the eastern slopes of the Andes of Peru, were named by Ruiz and Pavon in connection with the original description of the genus *Phytelephas*, but without distinctive characters other than the size of the fruits. Seemann did not know the Peruvian species, but was aware that the Panama palm was different from another *Phytelephas* found by Purdie in the upper valley of the Magdalena River in Colombia, supposed by Karsten to represent *Phytelephas microcarpa*. Spruce's account of the true *P. macrocarpa* of Peru leaves no doubt that the Panama species is entirely distinct. It has the trunk decumbent and creeping instead of upright, the leaves with fewer, larger pinnae, the spathes two instead of three or four, the male flowers with 36 stamens instead of 150 to 280. The fruits also are larger and contain more numerous nuts, but with fewer fruits in a head."[3]

The preceding note was published in relation to a shipment of seeds from Panama, but is somewhat misleading. The original locality of Seemann's palm at Cupica is not in Panama territory, but it was supposed that ivory palms from Panama would represent the same species. Later it was found that palms from several districts in Panama were different and five of the local types were named as new species.[4]

The palm described and illustrated by Seemann differs from the Panama species in having the surface of the fruits divided into larger areas, with coarser spines and a stronger development of fibers in the cortex and mesocarp. A fruit specimen in the collection of the Department of Agriculture agrees closely with Seemann's description and drawings.

Spruce's description of *Phytelephas macrocarpa* states that the trunk is very short and inclined or decumbent, while the trunk of *P. seemanni* grows to 20 feet long, though rising not more than 6 feet from the ground. The leaves of *P. macrocarpa* have about 100 pairs of pinnae, attaining 32 inches 1½ inches, while *P. seemanni* is credited with about 80 pinnae, 3 feet long and 2 inches broad. The fruits of *P. macrocarpa* usually ripen only 4 seeds, those of *P. seemanni* 6 to 9 seeds, "but generally 7." The smaller number of stamens, 36, and the larger number of spathes, 4 or 5, are characters of *P. seemanni*. The so-called spathes may represent large bracts at the base of the female inflorescence, but in that case the large size and small number of the bracts would be distinctive of the species.

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[3] U. S. Dept. Agr., Bur. Pl. Ind Bull. 242. Seeds and Plants Imported During the Period from April 1 to June 30, 1911, p. 68, No. 31115 Issued May 31, 1912.

[4] *Ivory Palms in Panama.* This JOURNAL **3**: 138–143. 1913.

Phytelephas karsteni Cook new species

Phytelephas microcarpa Karsten, Florae Columbiae Sp. Sel. **1**: 165 t. 82. 1861. Spruce, Journ. Proc. Linn Soc. Bot. **11**: 178. 1871. Not *Phytelephas microcarpa* Ruiz & Pavon, Syst. Veg. Peruv. **1**: 302. 1798

Another ivory palm was described by Karsten from the valley of the Magdalena River, Colombia, with no trunk and the fruits usually with only 4 seeds. As recognized by Spruce, this species is distinct from *Yarina microcarpa* in the absence of a distinct petiole as well as in the characters of the fruit. Karsten's palm evidently is more closely related to the other Peruvian species, *P. macrocarpa*, which likewise has a 4-seeded fruit with a fleshy pulp and female flowers of nearly the same size. Spruce says that there are 4 or 6 stigmas in *P. macrocarpa*, though only about 4 of the carpels are fertile, while Karsten's figures show only 4 stigmas. The entire female flowers of *P. karsteni* are 9 cm. long, according to the natural-size figures, while the flowers of *P. tumacana* must have been about 13 cm. long The styles and stigmas together are about 10 cm. long in *P. macrocarpa*, while in *P. karsteni* they are 8 cm long The stamens of *P macrocarpa* are about 1.2 cm. long, those of *P. karsteni* 1 5 cm. Karsten's figures of the female inflorescence show an involucre of many ovate-acuminate broadly overlapping bracts, about 9 cm. by 4 cm The insertions of such bracts are indicated as prominent transverse ridges on the axis of the adult inflorescence. Spruce describes *P. macrocarpa* as having an involucre of many small subtriangular scales around the base of the fruit-heads, with the tips of the scales separating into fibers when the fruit is mature.

Phytelephas longiflora Cook, new species

Female inflorescence with an involucre of many large bracts arranged in several longitudinal rows, probably in 8 rows, with 7 bracts in each row, the lower bracts larger and very broad, the middle smaller, the upper, subtending the flowers, much larger, triangular, about 8 cm. long and 3 cm. broad; female flowers attaining nearly 20 cm.; sepals narrowly triangular, 7 to 9 cm. long by 1 to 1.3 cm. broad; petals narrowly lanceolate, light colored, 15 to 16 cm. long by 1.5 cm. broad; staminodes numerous, slender, 3 cm long; pistil about 18 cm. long, the ovary 1 cm. long by 1.2 cm. broad, the style nearly 11 cm. long by 2 mm. thick, the stigmas 5, about 6 cm. long, about 1 mm. thick.

Specimens and photographs of the inflorescence were obtained in February, 1913, by H. Pittier (no. 5867) from a palm in a public park at Caracas, Venezuela, of unknown origin, but probably from the western part of Venezuela.

The description and measurements are taken from photographs of a female inflorescence and of dissected female flowers in fresh conditions, the flower photographs in natural size. The specimens are not now accessible, but copies of the photographs have been deposited in the National Herbarium as representing the type material.

The very large flowers and the involucre of numerous bracts arranged in longitudinal rows are striking features. There is no indication of such an involucre in any of the descriptions of other species, or in the specimens that have been compared. The bracts of *P. karsteni* are much larger, and broader above the base, instead of being triangular. The bract scars of *P. tumacana* are fewer and broader, and are scattered over the upper half of the last joint of the spadix, instead of being arranged in close series

Palandra Cook, new genus

Ivory palms related to *Phytelephas*, with an erect columnar trunk, attaining a height of 5 to 10 meters, roughened with prominent broadly triangular leaf-scars, covering the longer side of the short, oblique internodes. Leaves numerous and large, with more than 100 pinnae on a side, inserted in groups of 3 to 5. Male inflorescences forming a broad loose spike, the very large male flowers borne on long slender pedicels inserted on the axis in groups. Stamens long and slender as in *Phytelephas*, but more numerous, exceeding 1,000, forming a large spherical head, in striking contrast with the sessile, crowded, tassel-like male flower of *Phytelephas*. Female inflorescence similar to that of *Phytelephas*, the fruits armed with very large conical spines, the nuts rather narrow and oblong, the hilum sub-basal, rather small and very prominent, or raised on a projecting rim of the shell and with the adhilum forming a distinct point or projecting spine. Seedling with a long burrowing cotyledon and two bladeless sheaths, the second very long, the first leaf compound with numerous pinnae, as in *Phytelephas*

The type species is *Palandra aequatorialis* (Spruce), described originally from the plain of Guayaquil but supposed to extend northward into Colombia. It is the largest of the ivory palms, with a tall trunk and grouped pinnae that give it a distinct habit

The Tumaco ivory palm, on account of its erect trunk, was supposed at first to represent the species that Spruce had discovered in Ecuador, but it was clear from Spruce's description that the male inflorescence was unlike that of *Phytelephas*, and different also from *Ammandra*. Spruce's account of the floral characters is confirmed by a series of specimens and photographs obtained near Huigra, Ecuador, October 23, 1918, by Dr. J. N. Rose, no 22585. Several characters not given by Spruce are supplied from these specimens. The U. S. National Herbarium also has a specimen from Balao, Ecuador, Eggers no 14701, from the herbarium of Captain John Donnell Smith. The specimens of *Palandra* from Huigra are accompanied by two fruit heads which have small external spines and broad nuts with a very large mesial hilum. The occurrence of a species of *Phytelephas* in the same locality as *Palandra* is suggested.

The specimens of *Palandra* show sections of the male inflorescence with the very large male flowers borne on straight, slight tapering pedicels, 4 to 6 cm. long, and 2 to 3 mm. wide in the dry condition. The stamens are long and slender, as in *Phytelephas*, not the short minute stamens of *Ammandra*, but forming very large heads, 2 to 3 cm. in diameter, consisting of more than a thousand stamens, according to Spruce. The receptacle is not a thickened solid body as in *Ammandra*, but a flat expansion of the end of the pedicel with the margin showing minute rudiments of the floral envelopes, as in *Phytelephas*. The pedicels of the flowers are inserted on the axis in groups which may represent obsolete branches. It is remarkable that the branches have been suppressed while the pedicels have been elongated Since no other palm has such flowers or such pedicels, *Palandra* forms a strikingly distinct genus The interrupted or fastigiate pinnae are another unique character among the ivory palms, though a similar specialization appears in several genera of Cocaceae. The grouping of the pinnae on the rachis may have a genetic relation to the grouping of the flowers on the axis of the inflorescence

Pedicellate flowers evidently were a primitive feature of the Phytelephantaceae, as in the Sabalaceae and Pseudophoenicaceae Even in the Cocaceae pedicellate flowers are indicated as an ancestral character. Flowers of *Jubaea*, from palms growing at Santa Barbara, California, have pedicels from 2 to 8 mm long. Although shortened or suppressed in *Phytelephas*, pedicels have been retained in *Ammandra* and greatly enlarged in *Palandra*. In contrast with such retention or increase of the pedicels and receptacles is the elimination of the floral envelopes of the male flowers, which has gone much farther the Phytelephantaceae than in other families of palms. The opposite tendencies are shown in the specializations of the female flowers of the ivory palms, which are not pedicellate and have larger floral envelopes than in any other family.

Palandra aequatorialis (Spruce) Cook

Phytelephas aequatorialis Spruce, Journ Proc. Linn. Soc Bot **11**: 180. 1871

The palm is described by Spruce as having a stout, usually erect trunk 15 to 20 feet high; leaves 30 feet long with very short petioles, pinnae nearly 2 feet long inserted on the rachis in groups of 3 or 4; male inflorescences exceeding 4 feet in length, emerging from two large spathes, peduncle flattened, 18 inches long, 2 inches wide; male flowers numbering about 170, containing more than 1,000 stamens half an inch long, the filaments longer than the anthers. The male flowers are noted as white on the label of the specimen collected by Eggers A photograph of "a male tagua palm" with grouped pinnae standing at different angles to the rachis, was published in the Bulletin of the Pan-American Union, August 1913, from Esmeraldas, Ecuador. Another photograph, also from Esmeraldas, shows a female palm with evenly spaced pinnae.

From the specimens and photographs obtained by Dr Rose it appears that the palms near Huigra attained a height of 12 meters or more with the trunk about 50 cm in diameter at the base, tapering slightly and gradually upward. The grouping of the pinnae is irregular, sometimes with 5 or 6 pinnae together, and the lower pinnae wider apart than the upper. The number of pinnae appears to be about 120 on a side, on an adult palm with leaves 5 or 6 meters long. The burrowing cotyledon of the seedling is about 15 cm. long, the first sheath 8 cm., the second sheath 24 to 28 cm. and the first leaf about 70 cm. long, with the sheaths soon resolved into fine simple fibers as in *Ammandra.*

ZOOLOGY.—*The occurrence of* Naobranchia occidentalis *on the Pacific Coast of the United States.*[1]

DEOGRACIAS V. VILLADOLID, Stanford University, California (Communicated by DAVID STARR JORDAN).

In April, 1925, I collected specimens of parasitic copepods from the gills of *Parophrys vetulus* (Girard), taken from off Point Reyes, California in water about 50 fathoms deep. The flounder was taken in a "paranzella" net, operated by the trawlers, "Henrietta" and "Three sisters" of the Paladini Fish Company, San Francisco.

In the following June and July I made a trip to Puget Sound in the interest of my flat-fish studies. On July 6, 7, and 8, I was with Captain Fred Weisse of Snohomish, Washington, in his trawler, "Bonita," fishing in Tulalip Harbor, Fort Susan Harbor, and Saratoga Passage, off Whidby Island, San Juan County. During this trip, I collected a number of the same parasites from the gills of *Parophrys vetulus* and *Hippoglossoides elassodon,* both of which are common flounders of Puget Sound. They were all taken by an otter trawl at a depth of about 40 to 60 fathoms. On June 28, 1925, I collected a few of these parasites from the gills of *Platichthys stellatus,* the common flounder of the Pacific Coast of the United States. These flounders were taken from fish traps in Mutiny and Admiralty Bays in water of about 10 fathoms.

The specimens were sent to Professor Charles B Wilson, of Westfield, Massachusetts, a specialist on the group. To quote Professor Wilson, "The parasites you sent me from the gills of the small flounder, *Parophrys vetulus,* prove to be *Naobranchia occidentalis,* one of the Lernaeopodidae. The only other specimens of this parasite known were five females and one male taken from the gills of the Pacific cod, *Gadus macrocephalus,* at Chignik Bay, Alaska, by the "Albatross." You have thus added a new host and have brought the parasite within the limits of the United States. I will keep the specimens and add them to the collection in the National Museum."

It is of interest to note that *Naobranchia occidentalis* is more common

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[1] Received February 12, 1927.

in the northern waters of the Pacific as it approaches its type locality, Chignik Bay, Alaska than in the southern part of its range.

At the present writing, *Naobranchia occidentalis* is known to occur from Point Reyes, California to Chignik Bay, Alaska, in water from 10 to about 50 fathoms deep, from the gills of the Pacific cod (*Gadus macrocephalus*) and three flounders, namely: *Parophrys vetulus* (Girard), the common California "sole" or the sharp-nosed "sole" of Puget Sound; *Platichthys stellatus* (Pallas), the starry flounder; and *Hippoglossoides elassodon* Jordan & Gilbert, the rough-back "sole" or the mud "sole" of the Puget Sound.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY

424TH MEETING

The 424th meeting was held at the Cosmos Club, January 26, 1927, President BUTTS presiding. The Secretary announced the election to active membership of P. D. TRASK and MARIE STADNICHENKO.

Informal communications: O. E. MEINZER called attention to the Seventh Biennial Report of the State Engineer of New Mexico, recently published, which is likely to escape the notice of geologists but which contains five brief papers on ground-water hydrology prepared by members of the Division of Ground Water of the U. S. Geological Survey. These papers are based on investigations that were made possible by appropriations of the State Legislature two years ago. They are as follows

1. *The Roswell Artesian Basin*, by A. G. Fiedler. This is a preliminary report on one of the most productive artesian basins in the United States, and is based on one of the most thorough and intensive studies of artesian conditions that has ever been made

2. *The geology and artesian water prospects in the San Jose-Rio Puerco Valley, in Sandoval County*, by B. Coleman Renick. The geologic section includes rocks of pre-Cambrian, Pennsylvania, Permian, Triassic, Jurassic (?), Cretaceous, Tertiary, Pleistocene, and Recent age. Most of the strata are turned up along the western slope of the Nacimiento and San Pedro mountains, forming an artesian structure. Artesian conditions were predicted by Doctor Renick, and have since been demonstrated by test drilling. Thus, this investigation furnishes an example of an artesian basin that was discovered in the course of regular field work by the Geological Survey.

3. *Reconnaissance in Socorro County*, by Kirk Bryan. This brief paper reports the results of a reconnaissance preliminary to a geologic and groundwater survey that is still to be carried out. Shore features of an ancient lake, doubtless of Pleistocene age, were discovered in the San Augustin Plains, in Socorro and Catron counties. At its high stage, this lake reached above the present 6,900-foot contour, was at least 120 feet in maximum depth, and was about 25 miles long and 7 miles wide.

4. *Reconnaissance in DeBaca County*, by Kirk Bryan. This is likewise a brief report on a reconnaissance preliminary to a more thorough investigation.

5. *Geology and ground-water resources of the drainage basin of the Rio Penasco above Hope*, by B. Coleman Renick. The area described lies high up on the east slope of the Sacramento Mountains and is underlain by cavernous limestone of the Chupadera formation (Permian), where the main water table is 500 to 1,000 feet below the surface. The region affords a striking example of perched bodies of ground water. This water is supported by shale strata interbedded with the limestone and gives rise to large springs that furnish irrigation supplies and to one strong flowing well. Attention is called to the possibility of developing additional irrigation supplies from wells and of pumping the wells with water power developed by the pumped water on its way down to the irrigation district.

W C. ALDEN reported on the condition of the Gros Ventre landslide of June, 1925

Program: FRANK REEVES: *Thrust faulting adjacent to the Highwood Mountains, Montana.* The Highwood Mountains are one of several isolated mountain groups that rise out of the plains in central Montana According to Weed and Pirsson, this mountain group consists of an erosional remnant of basaltic and trachyandesitic breccias, tuffs, and lava flows resting on an eroded surface underlain by Upper Cretaceous strata. Both the volcanic debris and underlying Cretaceous strata are cross cut by several stocks and numerous dikes.

Field work by the author in the region during 1926 showed the presence of thrust faults in the upper Cretaceous strata that are exposed on the plains to the north, northeast, and east of the mountains. These thrust faults in general are concentric to the mountain area and in other respects are similar to the thrust faults adjacent to the Bearpaw Mountains Considerable evidence was obtained during the field work which corroborated the author's earlier expressed belief that the thrust faulting of the region is confined to the upper part of the Colorado shale and overlying formations and that the underlying rocks are neither folded or thrust-faulted. This shallow faulting, together with the fact that the faults are found only in that part of the plains toward which there is a plainsward dip from the mountains, makes it possible to offer the same explanation for these thrust faults as that previously offered for the Bearpaw Mountain faulting—namely, that they are the result of the plainsward slipping, probably on bentonite beds, of the weak upper Cretaceous strata, this slipping being brought about by the load of volcanic material and the earthquake shocks that accompanied the explosive phases of the volcanic eruptions. (*Author's abstract.*)

W. H. BRADLEY: *Tertiary and Recent fresh water algae reefs.* Algae reefs are common in certain parts of the Green River formation of Colorado, Utah, and Wyoming, and assist in interpreting the geologic history of the formation. In order better to interpret these reefs, the recent algal deposits of Green and Canandaigua Lakes, N. Y., have also been studied. Microscopic blue-green and green algae by their photosynthesis precipitate calcium carbonate from the lake waters. If the deposit is formed by one species it usually preserves the form of that plant, but if it is formed by a complex assemblage or felt of algae belonging to several species the deposit has instead a characteristic spongy or arborescent structure. The algal deposits have the form of isolated nodules, hemispherical or turbinate heads, and mammillary beds. Such forms are associated in reefs which may be narrow and fringing, broad, and bed-like, or intermediate between these two depending upon the shore and bottom profile of the lake in which they formed. Narrow fringing reefs form along steep shores because there the maximum depth at which fresh water algal deposits form rapidly is not far from the strand. Broad bed-like reefs on the other hand form in shallow flat-bottomed bays and the intermediate type on more or less gently sloping bottoms. Most of the algae reefs of the Green River formation are bed-like and range in area from a fraction of an acre to several square miles They range in thickness from a few inches to about 18 feet. About half of them consist of microcrystalline calcite which has a distinctive spongy or arborescent microstructure and probably were formed by an assemblage of several species of algae most of which were filamentous. Reefs with this microstructure have a variety of megascopic forms none of which is of unusual interest. The remainder of the reefs in the Green River formation were built chiefly by a single alga, *Chlorellopsis coloniata* Reis. This alga also forms reefs in the Miocene lake beds of the Rhine Valley but so far as the writer can determine is elsewhere unknown. Most *Chlorellopsis* reefs are laminated. This lamination is probably annual and in a few reefs is well enough defined to estimate the rate of growth of the deposits. The annual deposit consists of a layer of *Chlorellopsis* colonies formed during the summer and a thin dense layer without algal structure which was formed in the winter. These supposed annual layers average about 6 millimeters thick and therefore the reef which is about 7 feet thick must have required at least 355 years to form The bed-like algae reefs of the Green River formation indicate that the ancient lake bottom was nearly flat over large areas and was probably covered by only a thin sheet of water—perhaps between 3 and 15 feet deep. Furthermore the reefs seem to indicate stability of the lake level for periods of time measured in hundreds of years for they grew continuously. Such periods of stability suggest that at those times the lake maintained an outlet, for lakes in closed basins are extremely sensitive to climatic variations and as a consequence fluctuate greatly in volume. (*Author's abstract.*)

F E. MATTHES: *Influence of secondary faults on the development of the Grand Canyon topography* The plateau region through which the Grand Canyon is cut is commonly supposed to be made up of several great, massive blocks delimited by north-south trending master faults. As a matter of fact, these plateau blocks, and more especially the Kaibab, are traversed by numerous secondary faults of small throw and diverse trends. Being as a rule loci of relatively rapid erosion, these secondary faults have exerted a profound influence on the topographic development of the chasm. The positions and trends of many branch canyons, gulches, and minor recesses are determined by such faults, and in general the intricate, almost labyrinthine arrangement of the sculptural features of the Kaibab section is expressive of the fracture system as a whole In the vast panorama that unfolds itself from any prominent point on the rim of the Grand Canyon the presence of the secondary faults is not readily detected by the unaided eye. So small, as a rule, is the throw of these faults that the offsets in the strata are hardly noticeable. However, instrumental determinations of altitude on the sharply defined cliff tiers leave no doubt as to their reality. It was, in fact, in the course of the detailed topographic survey of the Grand Canyon, which was begun by the speaker in 1902, and has been completed recently by Richard T. Evans, that the existence of the secondary faults was first revealed. The elevations required for the contouring of the cliff tiers (several thousand were determined by accurate trigonometric methods from planetable stations on both rims of the chasm) soon developed the fact that there is a sensible break in the continuity of the strata along the axis of each major side canyon or important cross gulch, likewise at each accentuated constriction, gap, or recess, in the spurs that advance from the walls. Each outlying butte, each "temple," was found to be carved from a separate block having an attitude or tilt of its own. The marked asymmetry of the Kaibab section of the Grand Canyon (the course of the river is on an average more than twice as far from the rim of the Kaibab Plateau as it is from the rim of the Coconino Plateau) is explained not merely by the greater height of the Kaibab Plateau, nor by the fact that the surface of that plateau drains southward, into the Grand Canyon, whereas the surface of the Coconino Plateau drains away from it, but in large measure also by the greater prevalence of secondary faults on the Kaibab side as compared with the Coconino side. Toward the western margin of the Kaibab Plateau the secondary faults become progressively sparser, toward the eastern margin they become increasingly frequent and more closely spaced. The climax of fracturing is reached in the belt immediately west of the east Kaibab fault, where the Algonkian rocks are broadly exposed To the east of this master fault, on the other hand, the fracturing, as well as the flexing, rapidly die out in the flatlying strata of the Painted Desert. And there, significantly, side gulches are correspondingly rare. That the prevailing scarcity of side gulches in the Painted Desert is not due simply to lack of water is shown by the fact that wherever a fault does extend east of the monocline, there also is a gulch or at least a deep recess.

The extreme head of the Grand Canyon illustrates in a more telling way than any other part of the chasm the important rôle played by secondary fractures in the development of its topography. The chasm begins,—that is, it abruptly flares out from a width of a mile and a half in Marble Gorge to a width of eight miles (on the Kaibab side wholly) at the point where the Colorado reaches the base of the east Kaibab monocline, but this circumstance alone does not account for the remarkable and abrupt increase in width. At this point also begins the system of secondary faults. As this system does not appear to extend northward along the Kaibab monocline (which in consequence presents the appearance of a simple, gullied dip slope), it seems probable that the multiplicity of fractures in the upper part of the Grand Canyon—particularly in the region drained by Nankoweap, Kwagunt, and Chuar creeks—is closely associated with the presence of the Algonkian strata, which form a lens of weak materials intercalated between the Archean rocks and the Palaeozoic strata,—a lens that readily suffered deformation, thereby causing a local intensification of the fracturing of the overlying brittle strata. (*Author's abstract.*)

425TH MEETING

The 425th meeting was held at the Cosmos Club, February 9, 1927, President BUTTS presiding. The Secretary announced with regret the death of Dr. C. D. WALCOTT, Secretary of the Smithsonian Institution, former Director of the U. S. Geological Survey, and a Founder and former President of this Society.

Informal Communications: A. C. SPENCER called attention to an interesting course in geophysics, which some members of the U. S. Geological Survey are taking, offered at the Colorado School of Mines.

C. E. RESSER exhibited an algal "water biscuit" collected by Sir Douglas Mawson from a temporary lake in southern Australia.

Program: **William W. Rubey:** *The origin of the Mowry shale.* The Mowry shale, a relatively thin member of hard platy shale in the lower part of the Upper Cretaceous series, is widespread throughout the northern Rocky Mountain States. Its peculiar lithologic characteristics are due chiefly to its hardness which in turn is caused by the presence of a large amount of silica. The problem of the origin of this silica is thus a fundamental problem in the origin of the Mowry shale.

Field, microscopic, and chemical evidence from the Mowry shale of the Black Hills region and analogy with similar siliceous shales elsewhere indicate almost certainly that the silica in the Mowry shale was in some way derived from the alteration of volcanic ash. As a probable method of this derivation, it is suggested that the original ash was unusually siliceous, that it was decomposed by long exposure to sea water, and that silica dissolved from it was precipitated by the abundant decaying organic matter. A minor amount of secondary silicification may have occurred during consolidation and weathering. The few tests of siliceous organisms found in the shale are considered merely incidental fossils. The small amounts of clay, silt, and sand in the Mowry shale may be in part more or less altered volcanic products and in part normal clastic sediments (*Author's abstract.*)

George W. Stose: *Possible post-Cretaceous faulting in the Appalachians.* The peneplain developed on the tops of South Mountain and the Valley ridges in Pennsylvania, called the Kittatinny peneplain, has no counterpart in the Piedmont It is supposed to have been entirely removed by erosion. The peneplain that caps the highest ridges of the Piedmont, called the Schooley peneplain and regarded of later age, is 350 to 500 feet lower. May it not be that the Schooley peneplain is the Kittatinny faulted down?

The Triassic basin is bounded on the northwest by a normal fault of over 6,000 feet vertical throw in the vicinity of Gettysburg. Part of this movement took place near the close of Triassic sedimentation, preceding the formation of fanglomerates at the foot of South Mountain The larger part of the movement took place after the deposition of the fanglomerate, the latest recorded Triassic sediment. It is suggested that at least part of this later movement occurred after peneplanation and evidence was produced in support of this view.

Profiles at various places across the Appalachians in Pennsylvania were exhibited to show the effect of the application of this theory. The Kittatinny peneplain on South Mountain and the Valley ridges, 1600′–2000′ elevation, becomes the Schooley peneplain in the Piedmont, 1240′–1500′ elevation, with 350 to 500′ displacement; the Weverton peneplain on South Mountain and the Valley ridges, 1140′ to 1600′ elevation, becomes the Honeybrook peneplain in the Piedmont, 750′–1100′ elevation, with 400 to 500′ displacement.

The Harrisburg peneplain is not affected by the faulting. The hypothetical faulting therefore occurred between Weverton peneplanation and Harrisburg peneplanation, probably at the close of the Cretaceous. (*Author's abstract.*)

A. H. Redfield: *The Petroliferous Provinces of the United States.* As the major physiographic divisions of the United States formulated in 1916 by a committee of the Association of American Geographers, headed by Prof. N. M. Fenneman, are based primarily on regional structure, they constitute both a logical and a practical scheme of classifying the producing and potential oil fields of the United States.

Petroleum and natural gas have been produced commercially in eight of these major divisions: the Coastal Plain; the Appalachian Plateau; the

TABLE I—SUMMARY OF THE PETROLIFEROUS PROVINCES OF THE UNITED STATES

PROVINCE	REGIONAL STRUCTURE	TYPE OF PETROLIFEROUS STRUCTURE	AGE OF PETROLIFEROUS BEDS	EST. PROD'N 1859-1925
				Thous bbls
Coastal Plain	Monocline of Cretaceous and Tertiary beds, dipping gently seaward	*a* Faults and folds (E Cent Tex)	Up and Low. Cretaceous	1,237,383
		b Broad domes and terraces, less faulted (S. E Okla , S Ark , N La)	Up and Low. Cretaceous	
		c Faults and folds (S W Tex)	Eocene	
		d Salt domes, supposed to be intrusive (S. Tex , S La)	Chiefly Oligocene and Miocene.	
Appal'n Plateau	Great spoon-shaped basin of moderately disturbed Paleozoic beds	Small, discontinuous, irregular folds (N Y., Pa , E Ohio, W Va , E Ky , E Tenn)	Ordovician to Pennsylvanian	1,598,093
Central Lowland	Broadly folded Paleozoic beds	*a* Broad flat folds (W. Ohio, Ind , Ill , W Ky)	Ordovician to Pennsylvanian.	3,202,663
		b Imperceptibly folded, slightly dipping beds of varying porosity (E Kans , Okla N of Arbuckle and Wichita Mts).	Chiefly Pennsylvanian, some from Mississippian and Permian.	
		c Long, narrow anticlines (Red River Valley of S Okla and N Tex)	Ordovician, Permian, Pennsylvanian	
		d Broad arch, with minor wrinkles (N Cent Tex)	Pennsylvanian	
Great Plains	Broad basin of moderately folded Paleozoic and Mesozoic beds interrupted by dome-like uplifts of older rocks, (Black Hills, Bearpaw Mts , etc), veneered by continental Tertiary, partly concealing buried folds and uplifts in older rocks	*a* Minor folds along flanks of Rocky Mts and Black Hills, etc (Mont , E Wyo , E Colo)	U. Cretaceous, (some Carboniferous and (?) Jurassic)	270,348
		b Long, buried folds in Paleozoic (Panhandle of Tex , W Tex , E N Mex).	Permian.	
Wyoming Basin	Broad basin of moderately folded Cretaceous and Tertiary beds, partly concealing north-south folds of older rocks	Anticlines, some compressed and faulted (W. Wyo , Moffat Co , Colo)	Upper Cretaceous, some Permo-Carboniferous.	5,523
Colorado Plateau	Tableland of broadly folded, somewhat faulted and intruded, Paleozoic and Mesozoic beds, resting on pre-Cambrian foundation	Broad regional folds (W Colo , S E Utah, N W N Mex.).	Upper Cretaceous.	415
Pacific Valleys	Great synclines of Tertiary beds, resting on highly folded Mesozoic and older rocks	Crumpled and eroded anticlines, sealed monoclines (Cent Cal).	Miocene and Pliocene; some Upper Cretaceous.	1,290,735
Pacific Coast Ranges	Moderately to complexly folded, faulted, and intruded beds of Paleozoic, Mesozoic, and Tertiary age	Sharply to moderately folded and faulted anticlines (W Cal)	Tertiary, chiefly Miocene and Pliocene	999,417
			Total	8,604,577

Central Lowland; the Great Plains; the Wyoming Basin; the Colorado Plateau; the Pacific Valleys and the Pacific Coast Ranges (as well as some gas in the Arkansas Valley). In each of these major divisions of regional structure oil and gas occur under characteristic and distinctive conditions of structure and stratigraphy. (*Authors' abstract.*)

426TH MEETING

The 426th meeting was held at the Cosmos Club, February 23, 1927, President **Butts** presiding.

Informal Communications: C. E. **Resser** read letters of greetings from Secretary **Walcott** and Dr. A. F. **Foerste** to Dr. E. O. **Ulrich** on the occasion of his 70th birthday.

Program: **Arthur** M. **Piper**: *Metalliferous resources of Silver City, Idaho.* The Silver City region of southwestern Idaho, one of the old precious metals mining camps of the Northwest, has produced about 900,000 ounces of gold and 27,000,000 ounces of silver during the 60-year period from 1863 to 1923. Its decline as a generous producer has been a serious blow to the mining industry of the State, but geologic conditions suggest that its history is not yet closed.

The sequence of events in the legible geologic history has been: (1) intrusion of fine-grained argillite of possible Carboniferous age by late Mesozoic (?) granite, the magma being sodic, highly siliceous, and low in iron and magnesia; (2) regional fracturing, (3) deposition of silver ores in the southern part of the region at Flint, accompanied by intrusion of differentiates from the granite magma; (4) development of a mature erosion surface; (5) explosive extrusion of 1,500 feet of coarse basaltic tuff in early Tertiary time, followed by quiet outwelling of 500 feet of basalt flows; (6) outpouring of 2,000 feet of rhyolite flows, the succession being broken by an erosion interval of unknown age and duration, (7) regional block faulting, (8) deposition of silver-gold ore deposits at DeLamar and in War Eagle and Florida mountains, (9) regional faulting; (10) planation by sub-aerial agents; (11) deep dissection by glaciation and stream erosion.

The geologic structure involves complex block faulting, not recognized heretofore, during three epochs of deformation The dominant direction of shear for the first epoch is represented by the northward-trending veins of the Flint district. The secondary fractures cause an ever-present polygonal blocking and sheeting of the granite. Maximum crustal shortening was in a northeast-southwest direction, and the stresses were probably rotational. The second epoch involved high-angle block faulting of the granite and extrusives, the fractures being controlled in position by those of the preceding epoch. Certain of the fractures in the acute angles of major crustal blocks, were loci of subsequent deposition of the silver-gold ores. The vertical component of displacement along the major block faults is at least several hundred feet in some localities, and the shove along the fault planes is considerable. The third epoch of deformation is represented by prominent low-angle slicing, chiefly in the DeLamar district. These low-angle fractures have been thought to be older than the vein system but the present investigation has reversed that conclusion. They are normal faults, and the downthrow amounts to several hundred feet, although the shove is probably as much as 1,000 to 1,200 feet.

The ore deposits of the Flint district are found only in the granite. The veins are filled fissures and the dominant gangue mineral is quartz, of which the greater part is massive. The primary metallic minerals are the sulphantimonides of silver, almost every possible species being present, from silver-free stibnite on the one hand to argentite on the other. Pyrargyrite is the most abundant species. Small amounts of the arsenical silver minerals are also present. These argentiferous minerals are diluted by stibnite, tetrahedrite, and jamesonite, together with small amounts of chalcopyrite, galena, sphalerite, arsenopyrite, and pyrite. Unusual species are miargyrite ($Ag_2S \cdot Sb_2S_3$), xanthooonite ($3Ag_2S \cdot As_2S_3$), and stromeyerite ($Ag_2S \cdot Cu_2S$). Miaragyrite is quite widespread and rather plentiful in the Flint and Florida Mountain ore deposits. The ratio of gold to silver in the ores is about 1 to 700 by weight.

The ore deposits of War Eagle and Florida mountains and of DeLamar extend upward into the extrusives. The veins are filled fissures, vein breccias, and silicified shear zones, the last two types occurring more frequently in the extrusives. Quartz is again the most abundant gangue mineral. A great deal of lamellar quartz, possibly pseudomorphous after calcite, is found at DeLamar, together with beidellite. The Florida Mountain veins are characterized by the presence of cellular calcite, composed of thin plates each extended parallel to the basal plane and intersecting one another at random angles; of the potassic feldspar valencianite; and of beidellite, which in many places constitutes the greater part of the vein filling. The younger deposits are differentiated from those of the Flint district by the presence of a considerable though variable portion of gold and by an abundance of selenides. Gold occurs as the native metal, chiefly in the gold-silver alloy electrum. The comparatively rare silver selenide naumannite (Ag_2Se) equals or exceeds the abundance of argentite. Special mention should be made of owyheeite (essentially a silver-bearing jamesonite), and of the rare lead selenide, clausthalite ($PbSe$). The non-argentiferous diluents are chalcopyrite, pyrite, galena, and sphalerite, although the ores contain but one or two per cent of these species. Stibnite, tetrahedrite, and jamesonite are also present. The ratio of gold to silver varies from approximately 1 to 1 by weight in the primary zone of the Oro Fino vein of War Eagle Mountain to 1 to 139 at Florida Mountain.

Enrichment of the ore deposits of Florida Mountain by selenide minerals of probable supergene origin has been discovered by Dr. F. B. Laney, formerly of the United States Geological Survey.

The ores are medium- or low-temperature deposits which show no change in mineralogy within the vertical range of mining development, some 1,700 feet, except for the effects of supergene agents. Neither do they differ as they pass from one type of wall rock to another. It is to be expected therefore, that the ore deposits will extend without significant change to depths greater than any yet attained by mining. (*Author's abstract.*)

WALTER N. WHITE: *Recent work on the discharge method of estimating ground water supplies.* This paper describes an investigation begun in 1925 in the Escalante Valley, Utah, to develop the method, devised by G. E. P. Smith and described to the Geological Society of Washington on November 22, 1922, for determining the quantities of water discharged from the zone of saturation by plants that habitually use ground water, such as alfalfa, greasewood. and salt grass. This method is based on daily fluctuations of the water table. Its purpose is to use the discharge of the ground-water plants as a basis for estimating the available supplies of ground water. Automatic water-stage recorders used on 33 wells in localities of ground-water plants showed that during the growing season there is a marked daily fluctuation of the water table. The water table generally goes down during the day time, when transpiration by the plants is rapid, and rises during the night, when there is little or no transpiration. The daily fluctuations begin in the spring with the appearance of foliage, and cease in the fall after killing frosts. They are absent in plowed fields, cleared lands, and tracts of sage brush. In a field of alfalfa the fluctuations were nearly absent for several days after the alfalfa was cut. The maximum daily drawdown in wells observed during the investigation amounted to about 1¼ inches in a tract of greasewood and shadscale, 2¼ inches in a field of alfalfa, 3¾ inches in a salt-grass meadow, and 4¼ inches in a meadow of sedges and associated marsh grasses.

The quantities of water discharged each day were computed, in depth of water over the area, by the formula $y = 24\ r \pm s$. The quantity y is the specific yield, or quantity of water that drains out of the soil when the water table declines, expressed as a percentage of the volume of soil drained. The quantity r is the hourly rate of rise of the water table when the water table is at a mean elevation for the 24-hour period and there is no discharge from the zone of saturation. These conditions are found approximately during the middle of the night. The quantity s, expressed by either the plus or the minus sign, is the net fall or rise of the water table during the 24-hour period. The specific yield was determined by experiments with 16-gage steel cylinders, 1⅓ feet in diameter and 3 feet high, which were driven into the soil directly above the water table so as to inclose undisturbed columns of soil of the types in which the recorded daily fluctuations took place. After a cylinder had been driven it was converted into a water-tight vessel by soldering to it a bottom of sheet steel, and the top was made proof against evaporation by means of a cover. A well was then sunk into the column of soil, through which measured quantities of water were added or withdrawn and in which the resultant water levels were measured. The specific yield computed from data obtained from the undisturbed soil columns ranged between 2.4 and 9 per cent.

It was demonstrated by two independent sets of experiments that the results obtained by application of the formula to the data derived from the recorders on the field wells are substantially correct, but more refined experiments of the same kind are to be made in 1927. (1) Three soil tanks were used in which alfalfa, greasewood, and salt grass were grown. Each tank was provided with a recharge well, that fed water to the bottom of the soil column, and a shallow well that extended only slightly below the water table. The head in the recharge well was kept constant by means of an automatic device and the quantity of water fed into it during any interval of time could be read from a gage. The shallow well showed the fluctuations of the water table and gave a daily curve similar to those obtained in the field wells. Inventories were made at frequent intervals during the day and night of the water added to the zone of saturation, the net increase or decrease of storage in this zone, and consequently the quantity of water discharged from this zone. (2) By means of a tank experiment, the quantity of water required to produce one pound of dry alfalfa was determined. A measurement was then made of the quantity of dry alfalfa that was raised in a field under observation in which virtually the entire water supply came from the zone of saturation, and the quantity of water consumed in the production of this alfalfa was computed. This quantity agreed closely with that computed, by means of the formula, from the data obtained from an automatic recorder over a well in the same field.

Estimates were made of the rate of ground-water discharge from tracts having different kinds of vegetation and from the entire discharge area under investigation, but these are to be checked by more intensive work during the summer of 1927.

This investigation was conducted under the direction of E. O. Meinzer, geologist in charge of the division of ground water in the United States Geological Survey, who gave valuable advice at various stages in its progress both as to the methods to be applied and as to the interpretation of the results. (*Author's abstract.*)

GEORGE W. STOSE and ANNA I. JONAS. *Ordovician shale and associated lava in southeastern Pennsylvania.* The Ordovician shale, generally called Martinsburg but locally named Cocalico in the area north of Lancaster, occurs in a broad belt northwest of the Appalachian Valley and in several smaller areas south of the main belt. This shale, which overlies conformably Chambersburg limestone of Black River age west of the Susquehanna, unconformably overlaps on older rocks to the eastward, chiefly Beekmantown limestone of Canadian age but also Allentown limestone of Ozarkian age and Elbrook limestone of Middle Cambrian age.

In the vicinity of Jonestown, north of Lebanon, amygdaloidal basalt occurs at the base of the shale, resting on a floor of Beekmantown limestone. Certain purple and green shales occur at about the same horizon in the shale of the main belt and in most of the smaller areas to the south, and these shales are of volcanic origin according to the belief of the writers.

It is concluded that in this part of Pennsylvania uplift and erosion occurred in late Black River time, preceding Martinsburg shale deposition, and that during the same time basic lava was extruded from a vent near Jonestown. This period of volcanic activity is synchronous with that which produced the purple and green shale of probable volcanic origin in this part of the state and volcanic ash now preserved in the form of bentonite in central Pennsylvania, in Virginia, Tennessee, Kentucky, and Alabama and hence it is suggested that some of these ash eruptions may have come from the same vent as that from which the Jonestown lava came or from some near-by vent. (*Authors' abstract.*)

W. P. WOODRING, W. W. RUBEY, *Secretaries.*

BIOLOGICAL SOCIETY

695TH MEETING

The 695th meeting was held in the new assembly hall of the Cosmos Club October 23, 1926 at 8:10 p.m., with President OBERHOLSER in the chair and 180 persons present.

ALEXANDER WETMORE gave an account of the 44th meeting of the American Ornithologists' Union, recently held at Ottawa. He also gave a short account of Dr. WILLIAM MANN's African trip.

C W. STILES discussed the typification of the genus *Sarcoptes.*

DAVID FAIRCHILD gave an account of his recent trip through the tropics of the Old World.

H. C. OBERHOLSER reported, on the authority of another person, a curious case of the behavior of an English sparrow. The sparrow perched near a nest containing young robins. Each time that the parent bird fed the young and flew away, the sparrow flew to the nest. When he lit on the nest, the young robins at once opened their mouths, whereupon he immediately robbed the one that had just been fed of the food that had been given it.

Owing to the nonarrival of the films intended for the evening's program, it was necessary to postpone the announced program until the next meeting. A very acceptable substitute was provided by Dr. B. W. EVERMANN, who showed moving pictures of the elephant seal taken on Guadalupe Island, Mexico, and of the Steller sea lion taken at Año Nuevo Island near San Francisco.

696TH MEETING

The 696th meeting was held in the new assembly hall of the Cosmos Club November 6, 1926 at 8:05 p.m., with President OBERHOLSER in the chair and 227 persons present. New members elected: J. C. BLOEKER, Jr., Mrs. E. S. COBB, H. H. KNIGHT, MARY E. MCCLELLAN, HAROLD ST. JOHN. The program was as follows·

C. R. ASCHEMEIER, National Museum: *A talk on gorillas.*—In 1916 the speaker accompanied Prof. R. L. GARNER to the French Congo to obtain specimens of gorilla and chimpanzee for the U. S. National Museum. Landing at Cap Lopez, they passed up the Ogolelli River to Lake N'kami. Near there the first gorilla was seen, a young one captured by natives. A gorilla footprint seen here was fully 12 inches long. At Lake Ngovi fully 25 were seen together, making a raid on a plantain plantation, and a fine male was taken. From Ogouma a trip was made to Eschira along a trail followed by PAUL DU CHAILLU. At Kruso an old native was seen who claimed to have gone hunting with DU CHAILLU. Between Kruso and Ogouma, on the return trip, a fine gorilla was collected which is now mounted in the National Museum. It was 5 feet 3 inches high, weighed about 350 lbs., and had an expanse of 8 ft. Altogether about 75 gorillas were seen, of which 3 were collected. In general, the fierceness of the gorilla has been exaggerated. The animal usually retreats when possible, but if cornered or wounded fights fiercely. In the French Congo they occur in nearly every kind of country. Some natives do not eat the flesh, while others are very fond of it. In the opinion of the speaker there are not over 1,000 living gorillas, and strict enforcement of the game laws is required to prevent their extermination.

The paper was discussed by T. S. PALMER, C. W. STILES, G. B. SUDWORTH, and others.

The talk was followed by a five-reel picture, "The Gorilla Hunt," taken by BEN BURBRIDGE in the Lake Kivu region, and shown through the courtesy of the "Film Booking Offices of America."

697TH MEETING

The 697th meeting was held in the new assembly hall of the Cosmos Club November 20, 1926, at 8:10 p.m., with President OBERHOLSER in the chair and 84 persons present. New member elected: H. S. BERNTON.

T. S. PALMER gave an account of the game preserve in the Lake Kivu region in Africa, established in 1925 under the name "Parc Nacional Albert." In this preserve, covering about 1,000 square miles, the Lake Kivu gorilla is given absolute protection. The area can be well policed except on the south, where it touches a mandate zone which may at first create some difficulties in administration.

L. O. HOWARD stated that there is now hope of controlling the Opuntia pest in Australia by means of several species of mealybug which have been thoroughly established. Through their attacks the plants become brittle and dry. Unfortunately, one of the worst enemies of mealybugs in the world, *Cryptolaemus montrouzieri*, is a native insect in Queensland. The outcome of the struggle that is bound to arise will be watched with interest.

B. W. EVERMANN, California Academy of Sciences: *The conservation of the fisheries of the Pacific* (illustrated) —In natural resources of food or other commercial value, the Pacific is the richest of all the oceans. Of marine mammals, including fur seals, sea otters, whales and other cetaceans, sea lions, and the like, there are probably nearly 50 species, most of them at one time exceedingly abundant but now seriously depleted, some of them already commercially extinct. The fisheries proper, especially the Pacific salmon, the most important fishery in the world, are all greatly depleted as a result of inadequate protection. The whale fishery is faring as badly. Of 7 or 8 species found on the California coast only one (the humpback) is now abundant enough to justify whaling operations. Of about 2,000 whales taken on the California coast since 1918, over 90 per cent were of this one species; all the others are already commercially exterminated. The Alaska fur seal herd which, through the killing of females in the sea, was reduced from two to three millions in 1870 to only 127,000 in 1911, has increased since 1912 to 760,000 in 1926, as a result of the protection afforded by the International Treaty of 1912. There are remnants of more than a dozen other fur seal herds which, if given international protection, can be rehabilitated correspondingly. When international protection has been given to all the natural resources that frequent the high seas of the Pacific, they can easily be made to yield annually more than one billion dollars. (*Author's abstract.*)

GEORGE F. MITCHELL, Bureau of Chemistry. *The story of tea (illustrated).*—The speaker described the propagation and cultivation of the tea plant, *Thea sinensis*, and the manufacture of commercial tea. He used this as a background against which to show the possibilities of cassina (*Ilex vomitoria*), an indigenous plant growing along the coast from the James River in Virginia to the Rio Grande in Texas. Man in his natural state, that is, unaided by scientific research, discovered and utilized all of those beverage-producing plants which yield the alkaloidal principle, caffeine, as the tea, coffee, Paraguay tea, guarana, and cassina plants. Experiments have shown that cassina can be produced in this country for very much less than the cost of importing commercial tea, owing to the advantages that the cassina offers over tea, in both the growing and curing of the leaves. Tea leaves must be collected by hand, as only the young leaves contain the desired qualities. The cassina plant, however, can be harvested by machinery and the leaves removed by live steam, as all of the leaves can be used in the manufacture of cassina tea. The branches are then cut up by machinery and furnish at least 90 per cent of the fuel for operating the factory. Power and Chesnut have found as much as 1.67 per cent of caffeine in the leaves of cassina, the tannin content of which is much less than that of commercial tea. Experiments with cassina and experience in the growing and manufacture of tea in this country have convinced the speaker that cured cassina can be produced on a scale comparable with the tea gardens of the East Indies for about four cents per pound. Cassina can be made into green and black cassina, which are comparable with the average green and black tea, and also into maté products similar to the Yerba Mate used extensively in South America. Cured cassina is not only being used as a beverage similar to tea and coffee, but also in producing flavoring sirups and flavoring extracts. At the end of the address, carbonated cassina was served to the gathering to demonstrate its use as a flavoring sirup. (*Author's abstract.*)

698TH MEETING

The 698th meeting was held in the assembly hall of the Cosmos Club December 4, 1926, at 8:10 p.m., with Vice-president CHAMBLISS in the chair and 109 persons present. New member elected: D. D. STREETER.

H. D. FISH, University of Pittsburg: *A canoe trip through British Guiana* (illustrated).—The speaker described the botanic garden at Georgetown and Beebe's laboratory at Cartabo, which he occupied with 20 students in 1925. Colored slides of many of the characteristic animals of the region were shown. The method of hunting of the natives, who build platforms over small clear spaces in the forest and watch for game, was described. The speaker then gave an account of a canoe trip to Kaieteur Falls, 750 feet high, on the Potaro River, with splendid photographs of the Falls. He hopes to establish a biological station at this point.

G. C. LEACH, Bureau of Fisheries: *Trout propagation by the Bureau of Fisheries* (illustrated).—The Bureau of Fisheries, which has developed from the U. S. Fish Commission established in 1871, is divided into the Scientific Division, having charge of fisheries investigations; the Division of Fisheries Industries, having as its object the collection of statistics and the rendering of aid to the commercial fisheries in marketing their products; the Alaska Division, having charge of the enforcement of regulations covering the protection of the Alaska salmon, and also of the seals on the Pribilof Islands; and the Division of Fish Culture, having charge of the propagation and distribution of fishes throughout the United States and Alaska. There are 35 regular hatcheries and 65 sub-hatcheries. The Division of Fish Culture employs approximately 450 persons. The output of fish during the fiscal year 1926 was 5,232,000,000. Approximately 35 species of fish are propagated by the Bureau of Fisheries. Methods of propagation vary widely. Brook trout and rainbow trout yield to artificial propagation better than any other species. The brood stock at the hatcheries is held in ponds and the eggs are taken at certain seasons of the year and placed in hatching troughs where they are incubated in water having a temperature of 40° to 56°F. Brook trout eggs are collected during October, November, and December. They require approximately 30 to 35 days to hatch in a temperature of 50°F. Rainbow trout spawn during April and May, their incubation period being approximately the same as brook trout. The young fish are supplied with a yolk sac which contains enough food to last for 30 days. After absorption of the food sac the fish are fed on such artificial food as beef heart or beef liver ground to a pulp They are distributed or placed in streams when about two to four inches in length. Those held at the hatcheries for future brood stock reach the spawning age at from 2 to 3 years. An average 3-year-old brook trout will yield approximately 800 eggs. The eggs average from 350 to 500 per fluid ounce. The trout hatcheries are located in the mountain States in the East and West. Brook trout and rainbow trout are not propagated farther South than North Carolina and Tennessee. They prefer swift cool streams with gravelly bottoms. (*Author's abstract.*) S. F. BLAKE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Petrologists' Club met at the Geophysical Laboratory on April 19. Program: R. W. GORANSON, *Density of subcrustal material from gravity measurements;* G. W. MOREY, *The system,* $SiO_2 - H_2O$; E G. ZIES, *The concentration of metallic constituents by fumarolic activity. Example, the Valley of Ten Thousand Smokes.* Officers for the next season were elected, as follows: *Secretary,* GEORGE TUNELL; *Steering Committee,* L. H. ADAMS, W. F. FOSHAG, J. GILLULY. A field trip in the vicinity of Baltimore, under the guidance of J. T. SINGEWALD, was decided upon for May 7.

Obituary

DR. WILLIAM HEALY DALL, a member of the ACADEMY, died in Washington March 27, 1927, at the age of 81 years. Dr. DALL was born in Boston, Mass., and was educated in New England schools His interest in natural history led him to become a pupil in natural sciences under Louis Agassiz, and his most important work was in that branch of knowledge, though his interests were very wide and his early contributions to anthropology, geology, and geography of Alaska rank high. In his later years Dr DALL was one of the world's foremost students of recent and fossil Mollusca, his studies ceasing only with the inception of ill health two months before his death. He was for more than forty years Paleontologist in the U. S. Geological Survey and Honorary Curator of Mollusks in the National Museum.

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BOTANY.—*New plants from Central America.*—VIII. Paul C. Standley, U. S. National Museum.[1]

The eighteen plants here described as new are chiefly Costa Rican, and the greater part of them are based upon material collected by the writer. Many of these new species belong to the Araceae and Bromeliaceae, families in which the Costa Rican flora is exceptionally rich. Worthy of special note is the new *Gynandropsis* described from Costa Rica. This plant is strikingly beautiful because of its red flowers, and is well worthy of cultivation for ornamental purposes.

Anthurium tilaranense Standl., sp. nov.

Plant epiphytic, the caudex very short or elongate, the internodes abbreviated, the cataphylls weathering into coarse persistent fibers; petioles 15–20 cm. long, slender, shallowly sulcate on the upper side, geniculate 1.5–2 cm. below the base of the blade; leaf blades firm-coriaceous, green, glabrous, deeply 3-lobed to within 3.5 cm. of the base, 16–22 cm. long and of equal or greater breadth, the basal lobes 11–14 cm. long, oblong, 2.5–4 cm. wide, rounded at apex, convex on the lower margin, concave on the inner, the terminal lobe narrowly oblong, 16–22 cm. long, 3–5.5 cm. wide, abruptly narrowed to the cuspidate-acuminate apex, the 2 basal nerves divergent at an angle of about 80 degrees, margined to the base, the secondary nerves of the terminal lobe about 17 on each side, ascending at an acute angle, anastomosing remote from the margin to form a conspicuous collective nerve, all the nerves slender but prominent beneath; peduncles 7–15 cm. long; spathe oblong or ovate-oblong, 3–7 cm. long, 1.2–2.5 cm. wide, green, rounded and cuspidate at apex, united for about 1.5 cm. with the peduncle; spadix sessile, cylindric, rounded at apex, very densely many-flowered, 4–7 cm. long, 6–12 mm. thick, green or reddish.

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[1] Published by permission of the Secretary of the Smithsonian Institution. For the last preceding paper of this series see page 159 of this volume of The Journal. Received March 23, 1927.

Type in the U. S National Herbarium, no. 1,254,577, collected on tree in moist forest at Quebrada Serena, southeast of Tilarán, Guanacaste, Costa Rica, altitude about 700 meters, January 27, 1926, by Paul C. Standley and Juvenal Valerio (no. 46310). Collected also at Los Ayotes, near Tilarán, *Standley & Valerio* 45586

In general appearance as well as in technical characters this plant resembles Engler's illustration[2] of *A. denudatum* Engler, a Colombian species. In that, however, the leaves are essentially different, the lateral lobes being reflexed rather than directed forward, as in the Costa Rican plant. *Anthurium tilaranense* is strikingly different in foliage characters from any other species known from Central America.

Anthurium hypoleucum Standl , sp. nov.

Petioles about 18 cm. long and nearly 1 cm thick, shallowly sulcate above, geniculate at apex, leaf blades narrowly lance-oblong, 47–55 cm. long, 11–13 cm. wide, narrowed from below the middle to the obtuse apex, rounded at base, thick-coriaceous, green above, glaucous beneath, the costa very stout and prominent, the main lateral nerves slender but prominent, about 22 on each side, anastomosing to form a conspicuous collective nerve about 1 cm. from the margin; peduncle 30–50 cm. long, stout; spathe green, ovate-oblong, 2.5–4 cm. long, 1.5–2 cm. wide, cuspidate-acuminate, spadix in anthesis cylindric, sessile, slightly narrowed upward, 5.5 cm. long, 9 mm. thick, very densely many-flowered.

Type in the U. S. National Herbarium, no. 932125, collected on rocks at Santa Rosa, Guatemala, altitude 1,600 meters, April, 1908, by H. von Tuerckheim (no II.2214). Collected also at Mazatenango, Guatemala, November, 1914, *R. Tejada* 306.

The strongly glaucous lower surface of the leaves is a character not found in any other Central American *Anthurium* with which I am familiar

Pitcairnia Valerii Standl., sp. nov

Leaves unknown, only the inflorescence at hand; inflorescence paniculate, long-stalked, the panicle about 60 cm. long, twice branched, glabrous throughout, the branches few, the lowest about 17 cm. long, rachises slender, smooth, terete, many-flowered, the internodes 4–10 mm. long; primary bracts withered and fallen; bractlets lanceolate, greenish, scarious-margined, much shorter than the pedicels, their margins free but often involute about the pedicel; pedicels 5–7 mm long, the flowers deflexed, inferior portion of ovary turbinate, 4–5 mm. long, usually bluntly verruculose; sepals lanceolate, about 9 mm. long and 3 mm. wide, long-acuminate, green, glumaceous, with scarious margins; petals eligulate, linear, 2 cm. long, red, obtuse or acutish, stamens slightly shorter than the petals, stigmas exceeding the petals; free portion of the capsule lanceolate, 1.5 cm long, subulate-attenuate; seeds very numerous, brownish, filiform, about 6 mm long.

Type in the U. S. National Herbarium, no. 1,306,886, collected on steep bank at La Hondura, Province of San José, Costa Rica, altitude about 1,500 meters, March 9, 1926, by Juvenal Valerio (*Standley* 51879).

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[2] Pflanzenreich IV 23B: 263. 1905

The plant grew in such a difficult situation that the leaves could not be reached, and it was only with considerable risk that the inflorescence was secured. The species belongs to Mez's section *Eligulatae*, and is perhaps related to *Pitcairnia nuda* Baker, of British Guiana.

Pitcairnia flaviflora Standl., sp. nov.

Plants terrestrial or epiphytic, petioles about 25 cm. long, slender, the margins densely armed below with slender, divaricate, dark brown spines 2–3 mm. long, the upper part of the petiole with few distant minute teeth; leaf blades oblanceolate, about 65 cm. long and 9.5 cm. wide, acute, long-attenuate to the base and decurrent upon the petiole, thin, glabrous or nearly so, inflorescence about a meter high, simple, the flowers secund, sessile or on very short, thick pedicels, forming a dense spike 30 cm. long, the rachis obscurely tomentose; bracts large, soon withering, membranaceous, slightly tomentulose, covering the buds, sepals distinct, symmetric, equal, lanceolate, 3 cm. long, thick, long-attenuate to a subulate tip, dark red, slightly tomentulose above, petals orange, glabrous, narrowly spatulate, 4.5 cm. long, 8–11 mm. wide, near the base 4 mm. wide, obtuse or rounded at apex, eligulate; filaments 3.3 cm. long, the anthers 1 cm. long.

Type in the U. S. National Herbarium, no. 1,226,103, collected at La Palma, Province of San José, Costa Rica, altitude about 1,600 meters, February 3, 1924, by Paul C. Standley (no. 33091).

The orange color of the petals distinguishes this species from most of those known from Central America.

Tillandsia guanacastensis Standl., sp. nov.

Plants epiphytic, solitary, 15–17 cm. high, the scape 7–9 cm. long; leaves very numerous, densely rosulate, the inner ones 7–18 cm. long, the outer shorter, erect or recurved, somewhat inflated at base, the sheaths 2–3 cm. wide, abruptly or gradually narrowed into the long-attenuate blades, subulate at apex, grayish, densely covered with closely appressed scales, inflorescence equaling or slightly surpassing the leaves, flabellate, composed of 2 or 3 clustered spikes; spikes 3–5 cm. long, 12 to 19-flowered, dense, distichous, the bracts and flowers inserted obliquely; bracts coriaceous, about 4 mm. long, green, rounded on the back, sparsely whitish-lepidote, obtuse or rounded at apex, shorter than the sepals; flowers sessile; sepals broadly elliptic, asymmetric, 5 mm. long, rounded at apex, glabrate but very sparsely and obscurely lepidote; capsules cylindric, 18 mm. long and 2.5 mm. thick, apiculate, seeds pale brown, 2 mm. long, the hairs white, 1 cm. long.

Type in the U. S. National Herbarium, no. 1,254,424, collected in moist forest at La Tejona, north of Tilarán, Guanacaste, Costa Rica, altitude about 650 meters, January 25, 1926, by Paul C. Standley and Juvenal Valerio (no. 46045). Collected also in the same general region, at Naranjos Agrios, *Standley & Valerio* 46391.

Closely related to *T. Tonduziana* Mez, also Costa Rican, but in that species the inflorescence is pinnate and much elongate, and the sepals and bracts coarsely brown-furfuraceous.

Tillandsia orthiantha Standl., sp. nov.

Plants epiphytic, solitary, about 30 cm. high, acaulescent; leaves numerous, densely rosulate, mostly 20–28 cm. long, erect or ascending, conspicuously inflated at base, sheaths about 7 cm. long and 5.5 cm. wide, brown, thin, abruptly contracted into the blades, these 1.5–2 cm. wide just above the sheath, long-attenuate to a slender involute-subulate tip, grayish, densely covered with minute, whitish, closely appressed scales; inflorescence exceeding the leaves, the cauline bracts loosely inflated, much exceeding the internodes, erect; inflorescence twice pinnate, 7–8 cm. long, dense, the primary bracts ovate, 2–3 cm. long, equaling or exceeding the spikes, acuminate, thin, brown, densely and coarsely brown-furfuraceous, spikes approximate, 6–10, distichous, about 12 mm. wide and 2 cm long or shorter, 3 to 8-flowered, the flowers and bracts obliquely inserted, the spikes erect or strongly ascending; bracts 5–7 mm long, shorter than the sepals, obtuse, rigid, brown-furfuraceous; sepals asymmetric, oval, 5 mm. long, rounded at apex, rigid, brown-furfuraceous, the inner one keeled dorsally; capsule terete, 2 cm. long, subulate-acuminate, glabrous, the valves 5 mm. wide; seeds brown, 1.5–2 mm. long, the white hairs 1.5 cm long.

Type in the U S National Herbarium, no 1,252,715, collected in wet forest at Laguna de la Chonta, northeast of Santa María de Dota, Province of San José, Costa Rica, altitude 2,100 meters, December 18, 1925, by Paul C. Standley (no 42312) No 42348, from the same locality, represents the same species

This *Tillandsia*, also, is close to *T Tonduziana* Mez, but in that the pinnate inflorescence is elongate and open, its rachis flexuous (not thick and straight, as in *T. orthiantha*), and the branches usually reflexed.

Renealmia erythrocarpa Standl., sp. nov.

Plants small, 60–120 cm high, slender, leafy, the stems solitary or clustered, arising from slender rootstocks; lowest sheaths without blades, somewhat puberulent; upper sheaths glabrous or nearly so, nerved, the auricles extended about 2 mm. beyond the sheath, naked portion of the petiole about 1 cm long; leaf blades small, lance-oblong, 11–16 cm. long, 2–4 cm. wide, long-acuminate, acute at base, thin, green on both surfaces, glabrous, panicles several, rising from the rootstock, ascending, the slender peduncle 5.5 cm. long, the bracts suberect, 1.5 cm. long, the inflorescence 2–3 cm. long, densely few-flowered, the rachis slightly flexuous, hirtellous, the bracts lanceolate, 1–1.5 cm. long, green, hirtellous, attenuate, flower clusters 2 or 3-flowered, the pedicels 2–3 mm. long, calyx in fruit about 7 mm. long, puberulent, fruit scarlet, lanceolate in outline, glabrous, about 18 mm. long and 6 mm. thick near the base, attenuate to the apex, finely costate; seeds about 12, truncate at one or both ends, grayish, about 3 mm long.

Type in the U. S. National Herbarium, no. 1,254,613, collected in moist forest at Naranjos Agrios, near Tilarán, Guanacaste, Costa Rica, altitude about 700 meters, January 29, 1926, by Paul C Standley and Juvenal Valerio (no. 46373).

Related to *R. humilis* (A. Rich.) Peters, which has been found in Panama, but in that species the leaves are much narrower, and the globose fruit scarcely half as long and few-seeded.

Renealmia concinna Standl., sp. nov.

Plants 1 5 m. high or smaller; leaf sheaths scaberulous-puberulent, many-nerved, the petioles usually obsolete; leaf blades oblanceolate, 30–50 cm. long, 5.5–7.5 cm. wide, acute or acuminate, long-attenuate to base, thin, green and glabrous above, beneath slightly paler, sparsely and minutely pilose with slender spreading hairs; panicles erect, arising from the base of the plant, the peduncle slender, 9 cm. long or more, pubescent, the bracts erect, scarious, much shorter than the internodes; inflorescence 13 cm long and 2–3 cm. broad, interrupted, the rachis puberulent, the bracts oblong-ovate to lanceolate, 1–1.5 cm. long, thin, puberulent, deciduous, inconspicuous, flower clusters dense, 4 or 5-flowered, the peduncle 2–3 mm. long, the bractlets ovate, acute, about 8 mm long, the pedicels puberulent, in fruit up to 5 mm long; calyx green, 5 mm. long, puberulent, the 3 lobes rounded; fruit globose, 7 mm. long, red, costate, thinly puberulent, seeds about 4, 3–4 mm. long, very irregular, brown.

Type in the U S National Herbarium, no 1,227,906, collected in wet forest at Guápiles, Province of Limón, Costa Rica, altitude about 300 meters, March 12, 1924, by Paul C Standley (no 37355). No 37511 from the same locality belongs to the same species.

Renealmia mexicana Klotzsch is closely related, but differs in its more lax inflorescence, glabrous ovary, and more numerous seeds.

Renealmia densiflora Standl., sp nov.

Plants large, 1.5–2.5 m. high; leaf sheaths brownish, thin, many-nerved, minutely puberulent or glabrate, petioles obsolete, leaf blades oblong-obovate, 25–60 cm long, 9–17 cm. wide, rounded and caudate-cuspidate at apex, acute at base, thin, green and glabrous above, slightly paler beneath and minutely pilose, inflorescence arising from the base of the plant, erect, 35–90 cm high, the peduncle finely pubescent, stout, striate, the sheaths broad, inflated, rounded at apex, puberulent, erect, shorter than the internodes, often less than half as long; panicles cylindric and very dense, 7–14 cm long, 3–4 5 cm. thick, the bracts reniform or rounded-ovate, about 1 5 cm. long and usually broader, rounded or apiculate at apex, green, firm, puberulent or glabrate, persistent, flower clusters sessile, few-flowered, very dense, the flowers sessile or nearly so, bractlets lance-oblong, ovary densely puberulent, calyx red, 6 mm long, deeply 3-lobed, the lobes ovate, obtuse, puberulent or glabrate; fruit subglobose, glabrate, 5–6 mm. long, finely costate, seeds 6, subglobose, brown, 2 5 mm long

Type in the U. S. National Herbarium, no. 1,227,705, collected in wet forest at La Colombiana Farm, Province of Limón, Costa Rica, altitude about 70 meters, March 7, 1924, by Paul C Standley (no 36944) The following additional collections are referred here

PANAMA: Around Dos Bocas, Río Fató Valley, Province of Colón, alt. 40-80 m., *Pittier* 4213. Forests around Puerto Obaldía, San Blas coast, at sea level, *Pittier* 4327.

Renealmia exaltata L f is distinguished from the present plant by its larger size, ampler inflorescence, and the very large bracts of the scape. *R. mexicana* Klotzsch is similar in habit, but has an open inflorescence, glabrous ovary, and more numerous seeds.

Pittier reports the vernacular name "mata Andrea" from Puerto Obaldía.

Calathea cleistantha Standl., sp. nov.

Leaves all arising from a short thick rootstock, sheaths 18 cm. long, narrow, green, glabrous, attenuate to apex; petioles about 4.5 cm. long, slender, glabrous; leaf blades elliptic-oblong, asymmetric, about 25 cm. long and 9.5 cm. wide, abruptly, obliquely, and shortly cuspidate-acuminate, acute at base and abruptly decurrent upon the petiole, thin, green on both surfaces, glabrous; spikes ascending, about 3 cm. long and 1.5 cm. broad, arising directly from the rootstock on a peduncle 1.5 cm. long, this covered by the large thin bracts borne at its base; bracts of the spike about 5, erect, crowded, ovate or lance-ovate, acuminate, about 3 cm. long, whitish, glabrous or nearly so, somewhat distichous; flowers 4 in each bract, sessile, the bractlets linear, 2.5 cm. long; ovary glabrous, sepals linear, glabrous, 2.5 cm. long; corolla dark red-purple, 3 cm. long.

Type in the U. S. National Herbarium, no. 1,229,179, collected in wet forest near Guápiles, Province of Limón, Costa Rica, altitude about 400 meters, March 12, 1924, by Paul C. Standley (no. 37114).

I have seen no material of *C. Pittieri* Schum., described from the same general region but, judging from the description, it is closely related to the present plant. *C. Pittieri* is described as being much larger, more than a meter high, with decumbent spikes having internodes as much as 5 cm. long.

Calathea marantifolia Standl., sp. nov.

Plants small, about 60 cm. high, very slender, leafy, the leaves about 6; sheaths green, thin, slightly puberulent or glabrate, attenuate to apex, petioles slender, 7 cm. long or less, glabrous, the callous 1.5 cm. long; leaf blades lance-oblong, about 19 cm. long and 4.5 cm. wide, acuminate, at base acute, thin, green on both sides, very minutely puberulent beneath, especially on the costa; leaf at base of the inflorescence sessile except for the callous, the blade 12 cm. long; spike ellipsoid, 2.3 cm. long, 1.5 cm. wide, the peduncle 9 cm. long, puberulent above; bracts about 5, spirally arranged, yellowish green, appressed-pilose, about 18 mm. long, rounded at apex, finely nerved.

Type in the U. S. National Herbarium, no. 1,254,038, collected in wet forest at El Arenal, Province of Guanacaste, Costa Rica, altitude 485 meters, January 18, 1926, by Paul C. Standley and Juvenal Valerio (no. 45310).

This may be only a reduced form of *C. macrosepala* Schum., but that is normally much larger in all its parts, with proportionately broader leaves and more numerous bracts.

Stellaria nubigena Standl., sp. nov.

Prostrate or procumbent perennial, forming loose clumps or mats, the stems numerous, slender, 4–15 cm. long, glabrous, often densely leafy, the internodes 5–15 mm. long, leaves narrowly lance-oblong to oblanceolate-oblong, 6–12 mm. long, 2–4 mm. wide, acute, with a somewhat callous tip, sessile or often narrowed to a short petiole-like base, thick and firm, 1-nerved, the costa stout, salient beneath, glabrous, but the petioliform base frequently villous-ciliate, sometimes densely so; flowers mostly axillary and solitary, sometimes in 2 or 3-flowered cymes, the pedicels erect or ascending, 7–10 mm. long, glabrous, sepals 5, narrowly lance-oblong, 2 mm. long (in fruit nearly 3 mm. long), attenuate-acuminate, glabrous, stiff, erect, green, the margins scarious and whitish; petals white, shorter than the sepals; styles 3; capsule ovoid, obtuse, equaling the sepals, 6-valvate, the margins of the valves recurved; seeds about 10, reniform-globose, slightly compressed, brown, granular.

Type in the U. S. National Herbarium, no. 1,229,094, collected on wet bank on the southern slope of Turrialba Volcano, near the Finca del Volcán de Turrialba, Costa Rica, altitude about 2,300 meters, February 22, 1924, by Paul C Standley (no. 35344). The following collections also are referable to this species·

COSTA RICA· Las Nubes, Province of San José, alt. 1,500–1,900 m , *Standley* 38736, 38829, 38784.

Only four other species of *Stellaria* are known from Central America All of them differ from the plant here described in having ovate to deltoid leaves and villous or glandular pedicels.

Sisymbrium costaricense Standl , sp. nov.

Coarse erect annual, about a meter high, glabrous throughout (so far as specimens show; base of plant not seen), much branched, the branches green, terete, smooth, leaves sessile and clasping by a deeply cordate base, the auricles rounded; stem leaves lance-oblong, the largest 16 cm. long and 3 cm. wide, the upper much reduced, long-attenuate to the obtuse or acutish apex, finely, inconspicuously, and irregularly denticulate, deep green above, glaucescent beneath, racemes very long, laxly flowered, pedicels in anthesis 2–3 mm. long, in fruit up to 6 mm. long, stout, spreading or obliquely ascending, only the lowest subtended by leaflike bracts, the others naked, sepals oval-oblong, obtuse, 2 5 mm. long, green, with thin purplish margins, petals oblong, whitish, scarcely equaling the sepals; stamens shorter than the petals; pods sessile, 2 5–3 cm. long, over 1 mm. thick, straight, standing at almost a right angle to the rachis, the beak 2 mm long; seeds compressed, pale brown

Type in the U S National Herbarium, no 1,252,847, collected in moist thicket near El Copey, Province of San José, Costa Rica, altitude about 2,000 meters, December 22, 1925, by Paul C. Standley (no 42548). The following collections also may be cited·

COSTA RICA: Cornfields near El Copey, alt. 1,800 m., *Tonduz* 12190

PANAMA. In coffee plantation near El Boquete, alt. 1,200–1,300 m., *Pittier* 3058.

At one time I referred this plant to *S turritoides* Loes , a Mexican species, but better material shows that it is clearly distinct. *S. turritoides* has longer, nearly erect pods and larger flowers

Sisymbrium guatemalense Standl., sp. nov.

Plants glabrous (lower part of plant not seen), the branches terete, smooth, tinged with purple; cauline leaves longer than the internodes, sessile and clasping by a deeply cordate base, the auricles rounded, the blades thin, oblong, about 6 cm. long and 1.2 cm. wide, the uppermost smaller, acute or short-acuminate, remotely and minutely repand-denticulate, green above, glaucescent beneath; racemes naked, elongate, rather densely flowered, pedicels 4–6 mm. long, slender, divaricate or slightly ascending; sepals oval, obtuse, 2 mm. long, purplish; petals shorter than the sepals, stamens equaling the sepals; pods strongly ascending, straight or slightly incurved, terete, 8–15 mm. long, slightly over 1 mm. thick, narrowed at apex to a beak 1 mm. long, attenuate at base to a stipe 1 mm. long.

Type in the U. S. National Herbarium, no. 354938, collected at San Miguel Uspantán, Department of Quiché, Guatemala, altitude 2,000 meters, April, 1892, by Heyde and Lux (no. 3079).

Although related to *S. turritoides* and *S. costaricense*, this differs conspicuously in the very short pods, which are contracted into a stipelike base.

Cleome panamensis Standl., sp. nov.

Slender erect annual herb, about 30 cm. high, sparsely branched, the stems glabrate below, sparsely glandular-pilose above, the hairs short and inconspicuous; infra-axillary prickles 2 below each petiole base, yellowish, divaricate or recurved, scarcely 1 mm. long; leaves 3-foliolate, the petioles very slender, 2.5–6 cm. long, sparsely and minutely glandular-pilose; leaflets subequal, sessile or short-petiolulate (petiolule of terminal leaflet sometimes 3.5 mm. long), elliptic or obovate, 3–6 cm. long, 1.5–2.7 cm. wide, short-acuminate at apex or rounded and apiculate, the terminal leaflet acute at base, the lateral ones oblique, rounded on the outer side, very acute on the inner, thin, sparsely pilose along the nerves with short stiff spreading hairs, glabrate above, beneath paler, often with 1 or 2 minute weak prickles on the costa; racemes short-pedunculate, few-flowered, lax, in age as much as 5 cm. long, the bracts large and leaflike, the lowest 3-foliolate, the others simple, petiolate, the rachis sparsely glandular-pilose; pedicels in fruit 1.5 cm. long or less, very slender, flowers greenish, the sepals 2.5 mm. long, obtuse or acute, glabrous; petals 5 mm. long, short-clawed; gynophore glabrous, 3–4 mm. long, capsule terete, torulose, 4.5 cm. long, 2.5–3 mm. thick, glabrous, acute at base, long-beaked at apex, seeds globose-reniform, 2 mm. in diameter, pale brownish, smooth.

Type in the U. S. National Herbarium, no. 678347, collected at Marragantí, Panama, April 5, 1908, by R. S. Williams (no. 993). An imperfect specimen from Quiriguá, Guatemala (*Standley* 24290), probably is referable to the same species.

The most closely related species is *C. aculeata* L., which differs in having coarsely tuberculate and transverse-ridged seeds.

Gynandropsis chiriquensis Standl., sp. nov.

A large coarse herb or shrub, the branches thick, succulent, green, at first densely viscid-villous with short hairs and coarsely viscid-puberulent, finally glabrate; petioles slender, 9–16 mm. long, at first pubescent like the branches but soon glabrate; leaflets usually 7, unequal, oblong-lanceolate, mostly 6–19, cm. long and 1.2–3.8 cm. wide, long-attenuate to the acuminate apex, acute or attenuate at base, petiolulate, the petiolules 1 cm. long or shorter, dilated at base and united to form a disk, deep green above and sparsely viscid-puberulent, paler beneath, viscid-puberulent on the nerves, racemes short-pedunculate, naked, very dense, many-flowered, the rachis about 4 cm. long, puberulent, the pedicels slender, 9–14 mm. long, sparsely and minutely puberulent or glabrous; flowers nearly all sterile, no fertile ones seen; sepals unequal, lanceolate or lance-oblong, the larger ones 6–7 mm. long, narrowed to an obtuse apex, glabrous, green, with reddish margins; petals red, about 13 mm. long, glabrous, the blade obovate, rounded at apex, narrowed at base to a long claw; stamens 6, 2.5 cm. long, glabrous, the anthers linear-oblong, 3 mm. long; androphore 2.5 mm. long.

Type in the U. S. National Herbarium, no. 1,269,418, collected along the Caldera River below Quiel, Chiriquí, Panama, March 16, 1911, by H. Pittier (no. 3145).

According to description, this plant is closely related to the Colombian *G coccinea* Benth., of which no material is available for comparison. That species is described as glabrous, a term certainly not applicable to the present plant. The sepals also are described as smaller, and the androphore as longer.

Gynandropsis pulcherrima Standl., sp. nov.

Plants herbaceous or somewhat woody, 1–3 m. high, simple or sparsely branched, the young branches green, somewhat villosulous above, especially at the bases of the petioles, but soon glabrate; leaves 3-foliolate, the petioles slender, mostly 9–18 cm long, sordid-puberulent or glabrate, usually roughened with minute whitish verruculose elevations; leaflets sessile or nearly so, lance-oblong to oblong-elliptic, 10–20 cm long, 4–9 cm wide, acuminate, acute or cuneately narrowed at base, the lateral leaflets oblique, green above, slightly paler beneath, usually puberulent beneath on the veins, elsewhere glabrous; racemes terminal or opposite the leaves, short-pedunculate, the rachis stout, 6 cm. long or shorter, covered with the large dense elevated scars left by the fallen pedicels, only a few flowers open at one time; flowers mostly sterile, only a few of the lower ones fertile (very often none of the flowers of a raceme fertile); pedicels slender, mostly 1 2–2 cm long, glabrate; sepals very unequal, 5–10 mm. long, narrowly oblong to ovate, obtuse or acute, glabrate, green, sometimes red-margined; petals obovate, long-clawed, rounded at apex, glabrous, mostly 1.5–2 cm. long, varying from bright red to salmon or pinkish; torus 3–6 mm long, stamens 6, about 3 cm long, the anthers 3–3 5 mm long, fruit terete, 7–13 cm. long, 6–12 mm thick, fleshy, usually red, glabrous, obtusely contracted at apex, the stout style 2–3 mm. long, the stipe about 2 cm long

Type in the U S National Herbarium, no 1,253,694, collected in wet forest near Tilarán, Guanacaste, Costa Rica, altitude about 650 meters, January, 1926, by Paul C. Standley and Juvenal Valerio (no 44560). The following collections are referred here

COSTA RICA: El Arenal, Guanacaste, alt. 500 m., *Standley & Valerio* 45103. Quebrada Serena, Guanacaste, alt. 700 m., *Standley & Valerio* 46159, 46222. La Hondura, Province of San José, alt 1,500 m , *Standley* 37605. Las Nubes, Province of San José, *Standley* 38576 Near Finca La Cima, north of El Copey, Province of San José, *Standley* 42563, 42621. Santa María, Province of San José, alt 1,600 m., *Standley & Valerio* 43129, 44101. Orosi, Province of Cartago, *Standley* 39741, 39827. La Estrella, Province of Cartago, *Standley* 39209.

This plant is frequent in the mountain forests of Costa Rica, although seldom abundant. It is one of the most handsome and showy plants of the region.

Capparis Pittieri Standl., sp. nov.

Branchlets green, subterete, when young finely stellate-pubescent but soon glabrate; petioles thick and stout, 3–4 mm. long, glabrate, leaf blades oblong, 7.5–17 cm. long, 3–7.5 cm. wide, abruply short-acute, obtuse or rounded at base, subcoriaceous, when young closely stellate-tomentose on the upper surface but soon glabrous, the venation prominent, beneath paler, thinly stellate-pubescent with minute inconspicuous hairs, peduncles terminal, slender, 1.5–3 cm long, finely stellate-pubescent, usually 3-flowered, the pedicels slender, erect, 1.7–2.5 cm. long, minutely stellate-tomentose with pale brownish hairs, sepals elliptic-oblong, 4–5 mm. long, obtuse, open in bud, stellate-tomentose; petals elliptic-oblong, 7–8 mm long, obtuse or acutish, acute at base, sessile, thinly stellate-pubescent outside with whitish hairs, stamens numerous, the filaments very long and slender, glabrous, the anthers 1.5 mm. long; ovary ellipsoid, 2.5 mm long, glabrous, the slender gynophore about 4 cm long, glabrous.

Type in the U. S. National Herbarium, no. 578070, collected at Río Hondo, Costa Rica, altitude 50 meters, February 15, 1903, by H Pittier (no 16648).

This well-marked species is not closely related to any known from Central America The specimens have been determined as *C. filipes* Donn. Smith, but that species, with its narrow, long-acuminate leaves, silvery-tomentose beneath, and its pendent inflorescence, has little in common with *C Pittieri*.

BOTANY.—*Some Mimosaceae from Hispaniola.*[1] J. N. Rose and E. C. Leonard, U. S. National Museum.

Study of recent collections of *Mimosa* from Hispaniola resulted in the discovery of several little-known species and led us to revise this genus as represented in Hispaniola. There are now 7 recognized mimosas on the island, and one additional species still referred here which doubtless belongs elsewhere. This species, *M. angustifolia* Lam., was described rather fully in 1783, but so far as we can learn has not again been collected.

A new species of *Pithecolobium* has also been discovered among Dr. Abbott's collections.

In this connection we should like to call attention to the fact that there are ascribed to Hispaniola a number of Mimosaceae procured by the older collectors, which have not been found in recent times. One of these is *Inga filipes* Vent., described in 1803.

A NEW SPECIES OF PITHECOLOBIUM

Pithecolobium Abbottii Rose & Leonard, sp. nov.

Large tree, the younger branches densely brown-tomentose, unarmed; petioles 2 mm. long, brown-tomentose, glandular, the rachis 2 to 7 cm. long, brown-tomentose, glabrescent; pinnae 4 to 6 pairs, 1.5 to 4 cm. long, the leaflets 6 to 8 pairs, obovate or elliptic, 3 to 8 mm. long, 2 to 5 mm. broad, rounded and often shallowly emarginate at apex, narrowed or rounded at base, subsessile, chartaceous, convex, glabrous except for a small tuft of brownish

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 19, 1927.

hairs at base on the under surface, drying greenish-brown above, pale beneath, the venation obscure, inflorescence capitate, the heads globose, the pedicels 2.5 to 4 cm. long, glabrous or nearly so; calyx campanulate, 1.5 mm. long, glabrous; corolla 5.5 mm. long, the lobes narrowly elliptic, acutish, puberulent at apex, about half as long as the tube, stamens numerous, long-exserted, the tube about half as long as the corolla; fruit up to 10 cm. long, strongly curved, contorted after dehiscence, the valves 5 to 8 mm. wide, firm; seeds not seen.

Type in the U. S. National Herbarium, no. 1,079,252, collected near San Lorenzo Bay, on the south coast of Samaná Bay, Dominican Republic, April 29, 1922, by W. L. Abbott (no. 2258).

This species is nearest to *P. oppositifolia* Urban, differing chiefly in its fewer, glabrous leaflets and shorter pinnae.

REVISION OF THE GENUS MIMOSA IN HISPANIOLA

KEY TO THE SPECIES

- Valves of the pod not jointed; leaflets large, obliquely obovate. 1. **M. ceratonia.**
- Valves of the pod several-jointed; leaflets small, oblong, linear or nearly orbicular.
  - Erect or scandent shrubs; pods unarmed.
    - Petioles flat.
      - Pinnae 2 or 3 pairs, 5 to 12 mm. long. 2. **M. Leonardii.**
      - Pinnae a single pair, vestigial, often lacking, phyllodia leaf-like. 3. **M. extranea.**
    - Petioles terete or channeled.
      - Leaflets linear, 0.5 to 1 mm. broad; pods 4 to 5 mm. broad. 4. **M. domingensis.**
      - Leaflets oblong, 2 to 3 mm. broad, pods 8 to 10 mm. broad. 5. **M. mornicola.**
  - Prostrate herbs or clambering vines (sometimes woody at base), pods armed with slender setae.
    - Branches not prickly; valves of pod naked. 6. **M. pudica.**
    - Branches prickly; valves of pod setose. 7. **M. invisa.**

1. MIMOSA CERATONIA L. Sp. Pl. 523. 1753.

Acacia ceratonia Willd. Sp. Pl. 4: 1091. 1805.

Lomophis ceratonia Raf. Sylv. Tellur. 118. 1838.

Slender, trailing or climbing vine, up to 6 meters long (sometimes shrubby); stems glabrous, angular, armed with flat prickles about 1.5 mm. long; stipules subulate, 2 to 3 mm. long, petioles and rachises together 8 to 12 cm. long, armed with sharp curved prickles 1 mm. long, glabrous; pinnae 1 to 5 pairs, the rachilla slender and armed with small curved prickles; petiolules about 1 mm. long, leaflets 3 to 5 pairs, obliquely obovate, 1 to 1.5 cm. long, 5 to 13 mm. broad, rounded at both ends, thin, glabrous, paler beneath, 3-nerved; heads numerous, in terminal racemes or narrow panicles, or few and in the axils of the upper leaves, globular, 10 to 12 mm. in diameter, white or pinkish; peduncles 1 to 2 cm. long, prickly; calyx 0.75 mm. long, the lobes triangular, unequal; corolla 2 mm. long, the lobes usually 3, elliptic, obtusish, 1 mm. long, stamens usually 6, 5 to 6 mm. long; pod oblong, straight or slightly curved, 3 to 5 cm. long, 12 to 15 mm. broad, flat, thin, glabrous, shining, not jointed, the margins armed with flat hooked prickles 2 to 2.5 mm. long; seeds dull, flat, oval, 5 mm. long, 3 mm. broad, glabrous, 7 or 8 in each pod.

Type locality: Tropical America, perhaps the West Indies.

Distribution. Hispaniola to St. Vincent.

Specimens examined:

DOMINICAN REPUBLIC. In clearing, vicinity of Laguna, Samaná Peninsula, *Abbott* 399 Common creeper in secondary growth, Laguna, *Abbott* 430. Vicinity of Samaná, *Abbott* 476. Without locality, *Wright, Parry & Brummel* 66.

A well marked species, easily distinguished by its large leaves and broad, not jointed pods.

2. Mimosa Leonardii Britt. & Rose, sp. nov.

Low shrub, twigs slender, gray, terete, glabrous or the younger minutely puberulent; prickles paired, infrastipular, reflexed, 3 to 4 mm. long, very sharp; petiole, rachis, and rachilla strongly flattened, channeled above, glabrous, armed with small, single or paired, sharp, recurved prickles, the petiole with rachis 3 to 6 cm long; pinnae 2 or 3 pairs, widely separated; leaflets 1 to 3 pairs, oblong, 4 to 8 mm long, 2 to 4 mm broad, rounded at apex, round and oblique at base, thick, entire, glabrous; veins and midrib obscure, the pair of lateral veins joining the midrib at base; peduncles axillary, single or in clusters, 8 mm. long or less, puberulent; flowers sessile, in heads 6 to 7 mm. broad, pinkish, calyx 0.5 mm. long, 4-lobed, the lobes low, blunt, minutely ciliolate, corolla 1 75 mm long, the tube narrowly campanulate, the lobes 4, erect, oval, acutish at apex; stamens 5 to 8, the filaments glabrous, 2 5 to 4 mm long, the anthers oval, 0.5 mm. long; ovary 1 25 mm long, pubescent; pod 4 to 5 cm long, 6 to 8 mm. broad, flat, curved, the margins thickened, 8 to 10-jointed, the joints square, glabrous, purplish; seeds orbicular, flat, 2 5 mm. in diameter

Type in the U S. National Herbarium, no 1,300,376, collected on a dry bank of the Puilboreau Road near Ennery, Haiti, altitude 350 meters, January 22, 1926, by E. C. Leonard (no. 9105).

This species is a very distinct one, easily recognized among the other West Indian mimosas by the armed, flattened petioles and rachises.

3. MIMOSA EXTRANEA Benth Trans. Linn. Soc Bot. 30: 433. 1875

Slender unarmed shrub up to 3 meters high, branches erect or ascending, reddish brown, glabrous, the younger ridged, the ridges extending in 3's from the bases of the phyllodia, stipules not seen; phyllodia linear, 3 to 6 cm long, 2 to 5 mm. broad, obtuse at apex, narrowed at base, firm, dark green, prominently 3-nerved, often without leaflets; pinnae minute, 1 pair at the tip of the phyllodium, each with a single pair of leaflets, leaflets nearly orbicular, 1 mm in diameter; inflorescence a terminal panicle, the flowers capitate, numerous, peduncles 1 to 2 cm long, puberulent; heads globose, about 8 mm in diameter at flowering; calyx 0.75 mm. long, the lobes 4, triangular; corolla 3 mm. long, funnelform, the lobes 4, elliptic, 1 mm. long, obtusish, pink at tip, stamens usually 6, 4 to 5 mm. long, ovary pubescent; style equaling the stamens, pods 3 to 4 cm. long, 5 to 6 mm broad, 5 to 8-jointed, slightly constricted at the joints, flat, reddish brown, seeds flat, 3 5 mm. long, 3 mm. broad.

Type locality. Santo Domingo

Specimens examined:

HAITI: Puilboreau Road in vicinity of Ennery, Département de l'Artibonite, *Leonard* 8815, 8828, 8882. Between Gonaives and La Hotte Rochés, *Nash & Taylor* 1548.

This is the only species of *Mimosa* with well developed phyllodia.

4. MIMOSA DOMINGENSIS (Bertero) Benth. Journ. Bot. Hook. 4: 409. 1842

Acacia domingensis Bertero; A. DC. Prodr. 2 464. 1825.
Mimosa diplacantha Benth. Trans Linn. Soc. Bot. 30. 424. 1875.

Shrub; twigs branching, the older terete, gray, the younger obscurely angled, reddish, glabrous, sparingly armed with small curved prickles, stipules linear, spinelike, 1 to 2 mm. long; petioles with rachis 2 to 5 cm. long, pulvinate at base, armed at the insertion of the pinnae with a pair of curved prickles; pinnae 1 or 2 pairs, pulvinate, channeled above, 1 to 1 5 cm. long, unarmed or bearing an occasional curved prickle, leaflets 7 to 10 pairs, the lower pair reduced to minute scales, the remainder sessile on a minute pulvinus, linear-oblong, 3 to 5 mm. long, 0.5 to 1 mm. broad, rounded at both ends, oblique at base, firm, glabrous, obscurely 3-nerved; flowers capitate, borne in the axils of the upper leaves; peduncles elongating to 3 cm., puberulent and glandular, reddish; heads ovoid, about 10 mm. long and 18 mm. broad at flowering, pink; calyx 1 mm. long, the lobes minute, triangular; corolla 2.5 cm. long, the lobes 4, triangular-ovate, 0.75 mm. long, acutish, stamens 8, 4 to 5 mm. long, the filaments tapering at tips, the style slightly exceeding the stamens, the stigma minute, pods 2.5 to 3 cm. long, 4 to 5 mm. broad, 5 to 7-jointed, slightly constricted at the joints, flat, glabrous, reddish, acuminate at tip, narrowed at base; seeds blackish, flat, nearly orbicular, 2 5 mm in diameter, glabrous.

Type locality. Santo Domingo, the type collected by Bertero.

Specimen examined:

DOMINICAN REPUBLIC. Azua, *Rose, Fitch & Russell* 4018.

Mimosa domingensis is a well marked species, distinguished by its linear leaflets. The well developed pulvini indicate that the plant is sensitive.

5. MIMOSA MORNICOLA Urb. Symb. Ant. 7: 228. 1912

Scandent shrub; twigs armed with curved spines 2 mm. long, the young branches minutely white-puberulent, often unarmed, the petioles decurrent in 3 parallel blackish costae, the intercostal areas brown; stipules filiform, 3 to 9 mm. long, subulate, more or less curved; leaves 4 to 7 cm. long, with 4 to 9 pairs of pinnae, the rachis and rachillae grooved and minutely pubescent above, armed (in the older leaves) with 2 or 3 infrastipular curved prickles, the pinnae 1 5 to 2 5 cm. long, rather strongly curved, terminated by a pair of curved prickles 1.5 mm. long, the younger leaves unarmed or with a few prickles; leaflets 6 to 9 pairs, becoming black or brown when dry, the first pair reduced to minute subulate scales, the remainder oblong, 4 to 6 mm. long, 2 to 3 mm. broad, rounded or broadly obtuse at apex, obliquely truncate or subcordate at base, entire, glabrous on both surfaces, the midrib obscure above, prominent beneath; inflorescence paniculate, 10 cm long, minutely puberulent; flowers numerous, in ovoid-globose heads 4 to 6 mm. long; calyx 1 mm. long, 4-lobed, the lobes triangular, corolla funnelform, 1.5 to 1.8 mm. long, the lobes triangular-ovate; stamens 4 to 9, the filaments about 3 mm. long; ovary elliptic, villous, pods 5 to 6 cm. long, 8 to 10 mm. broad, 5 to 7-jointed, minutely puberulent, the margins undulate; seeds flat, nearly orbicular, 4 mm. in diameter.

Type locality. Morne Bonpère, Haiti. Type collected by Buch (no. 685).
Specimens examined.
HAITI Morne Bonpère, *Buch* 685 (photograph and fragment of leaf). Bank of stream, l'Atalaye Plantation, vicinity of St. Michel, *Leonard* 7014.
DOMINICAN REPUBLIC Azua, *Rose, Fitch & Russell* 3994. Nigua, *Faris* 447.

A good deal of variation is shown by the specimens cited. Faris's no. 447 from Nigua is a flowering twig with the facies of the type, but differing in its armed leaves and greater number of pinnae (8 to 10 pairs), and also in its more numerous leaflets (8 or 9 pairs on each pinna) and stamens (6 to 9). The type of *M. mornicola* is described as an unarmed shrub with not more than 8 pairs of pinnae, each with 7 or fewer pairs of leaflets, and flowers with but 4 or 5 stamens. Mature twigs with fruit, represented by Rose, Fitch and Russell's no 3994 and Leonard's 7014, have both stem and leaves armed with sharp prickles These differences are probably due to the age of the twig and variable environmental factors. The Azua specimen differs further in the slightly larger leaflets, which are broader in proportion than those of the other plants examined.

6. MIMOSA PUDICA L. Sp. Pl. 518. 1753

Mimosa pudica glabrata A. DC. Prodr. **2**: 426. 1825

Herbaceous, or woody at base, branched, usually prostrate, up to 5 dm. long, the stems armed with flat, straight or slightly curved prickles 1 to 4 mm. long, hispid, hirsute, or glabrate, stipules lanceolate, acuminate, 3 to 6 mm. long, striate, hirsute, glabrate, sometimes ciliate; petioles slender, 1 to 6 cm. long, pulvinate at base, deflexing when touched, hirsute or glabrate, often more or less finely puberulent above; pinnae 1 or 2 pairs (when 2, the pairs approximate), 1 to 6 cm. long, hirsute or glabrate, pulvinate at base, the pulvinus and channeled upper surface finely pubescent; first pair of leaflets borne at the summit of the pulvinus, reduced to small linear spreading bracts about 1 mm. long; normal leaflets 15 to 25 pairs, narrowly oblong, 3 to 10 mm. long, 1 5 to 2 mm. broad, acutish or obtuse at apex, oblique and rounded at base, thin, glabrous above, sparingly strigose beneath, meeting above in pairs when touched; heads ovoid, 8 to 10 mm. long, pink or purplish, axillary; peduncles 1 to 3 cm. long, glabrous or sparingly hirsute, bracts obovate or oblong, 0.5 to 0 75 mm. long, acutish, the lowermost ciliate, calyx minute, the lobes unequal, awnlike; corolla funnelform, about 2 mm. long, the lobes 4, nearly 1.5 mm long, obtusish; stamens 4, long-exerted, pink or white, pods numerous, crowded in a head, linear-oblong, 1 to 1.5 cm long, 3 to 4 mm broad, 2 to 5-jointed, constricted at the joints, the sides glabrous, the margins prickly-hispid; seeds brown, flat, nearly orbicular, 2.5 mm. in diameter.

Type locality: Brazil.
Distribution: West Indies and continental tropical America.
Specimens examined·
HAITI Open mountain slope, Furcy, *Leonard* 4290. Along small stream, Mt. La Cidre, *Leonard* 7536. Meadow, Dondon, *Leonard* 8589, 8657. Roadside, Plaisance, *Leonard* 9179. Meadow, Pilate, *Leonard* 9588. River bank, Gros Morne, *Leonard* 9894.
DOMINICAN REPUBLIC. Wet meadow along railroad, Sánches, Samaná

Peninsula, *Abbott* 14. Haina, *Faris* 39, 159. Sánchez, *Rose, Fitch & Russell* 4352. Without locality, *Wright, Parry & Brummel.*

This is the common sensitive plant of tropical America, so called because it responds to irritation by a rapid drooping of the petioles and folding together of opposed leaflets. The plants are often found in this "sleeping" condition in the early morning, but gradually expand as warmed by the rising sun. Under cultivation the plant often becomes robust and assumes an erect position. Its common name in the Dominican Republic is morir-vivir; in northern Haiti it is called ronté.

7. MIMOSA INVISA Mart Herb. Fl. Bras. 121. 1837

Schrankia brachycarpa Benth. Journ. Bot Hook. 2: 130. 1840
Mimosa diplotricha Wright in Sauv. Pl. Cub. 34. 1873.

A herbaceous clambering vine 1 to 2 m long, the branches angled with numerous reflexed prickles, pilose when young, pinnae 4 to 8 pairs; leaflets many pairs, oblong-linear, 3 to 4 mm. long, glabrous on both sides, ciliate; flowers in dense heads; calyx and corolla glabrous; stamens twice as many as the petals, purplish, pods linear-oblong, 1 to 2 cm. long, setose on the valves and margin, more or less pubescent.

Type locality Rio de Janeiro, Brazil.

Distribution: Brazil, north to Mexico and the West Indies.

Specimen examined.

HAITI In meadow at sea-level, near Port Margot, *Nash* 303

The type of *M. invisa* from Brazil has not been examined. It is possible that the common North American plant which has long passed under this name is specifically distinct

EXCLUDED SPECIES

MIMOSA ANGUSTIFOLIA Lam Encycl. 1: 12 1783

Erect tree; bark brown or grayish; wood white and very strong; leaves with 4 or 5 pairs of pinnae each bearing from 30 to 50 pairs of narrow leaflets, these green above and pale beneath; flowers racemose, pods 10 to 13 cm. long, 6 to 8 mm. broad, appressed, yellowish; seeds small, orbicular, usually 12 in each pod.

Type locality: Santo Domingo.

Plant not seen. The racemose inflorescence and long, nonjointed pods are characteristic of the genus *Acacia*, to which this species, probably, should be referred.

ARCHEOLOGY.– *Potsherds from Choctaw village sites in Mississippi.*[1]

HENRY B. COLLINS, JR., U. S. National Museum. (Communicated by D. I. BUSHNELL, JR.)

Archeological research in the southeastern states can probably never reach the point of exactness that it has in the Southwest. There are

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[1] Published by permission of the Bureau of American Ethnology, Smithsonian Institution. Received April 12, 1927.

no stone ruins, and barring a few exceptional kitchen-middens along the coasts, no extensive refuse heaps showing successive culture layers. The climate, furthermore, is not such as to preserve textiles, basketry, wood-work or other perishable objects so that about all that is now left of the once high material culture of the Southern tribes is the pottery and the ornaments and implements of stone, shell, and bone. It is very desirable, therefore, to seize upon every available source of tribal identification of the cultures represented, and to accomplish this end there is probably no safer beginning than to locate the historic Indian village sites and to study their type of cultural remains for comparison with other sites of unknown age. This method was followed during the past two summers when for several months the writer carried on preliminary archeological work in Mississippi for the Bureau of American Ethnology in coöperation with the Mississippi Department of Archives and History, represented by Mr. H. H. Knoblock.[2]

The region chosen for investigation was the east central section of the state, the former home of the Choctaw. A brief reconnoissance of this area was first made and a number of mounds and Choctaw village sites were located and later explored. Wherever possible, surface collections of potsherds, flint artifacts, etc., were made. It is to such collections of potsherds that attention is here called, for these seem to indicate that there was a definite type of historic Choctaw pottery, entirely distinct from that of any other region.

In the accompanying plate are shown examples of this type of pottery from the sites of two old Choctaw villages, Chickachae in the northeastern part of Clarke County, and Ponta (Coosa) in northern Lauderdale County. According to Prof. H. S. Halbert, who worked for many years among the Choctaw in Mississippi, Ponta was occupied as late as 1846.[3] The time of the abandonment of Chickachae is not definitely known but it probably took place between 1810 and 1834, during which period the greater part of the Choctaw lands were signed away and their former owners forced to migrate west of the Mississippi River. The first reference to Ponta and Chickachae is found in the manuscript journal of Régis du Roullet, the French army officer, who in 1729 made the first official exploration of the Choctaw country.[4] The two villages again appear on the map and in the

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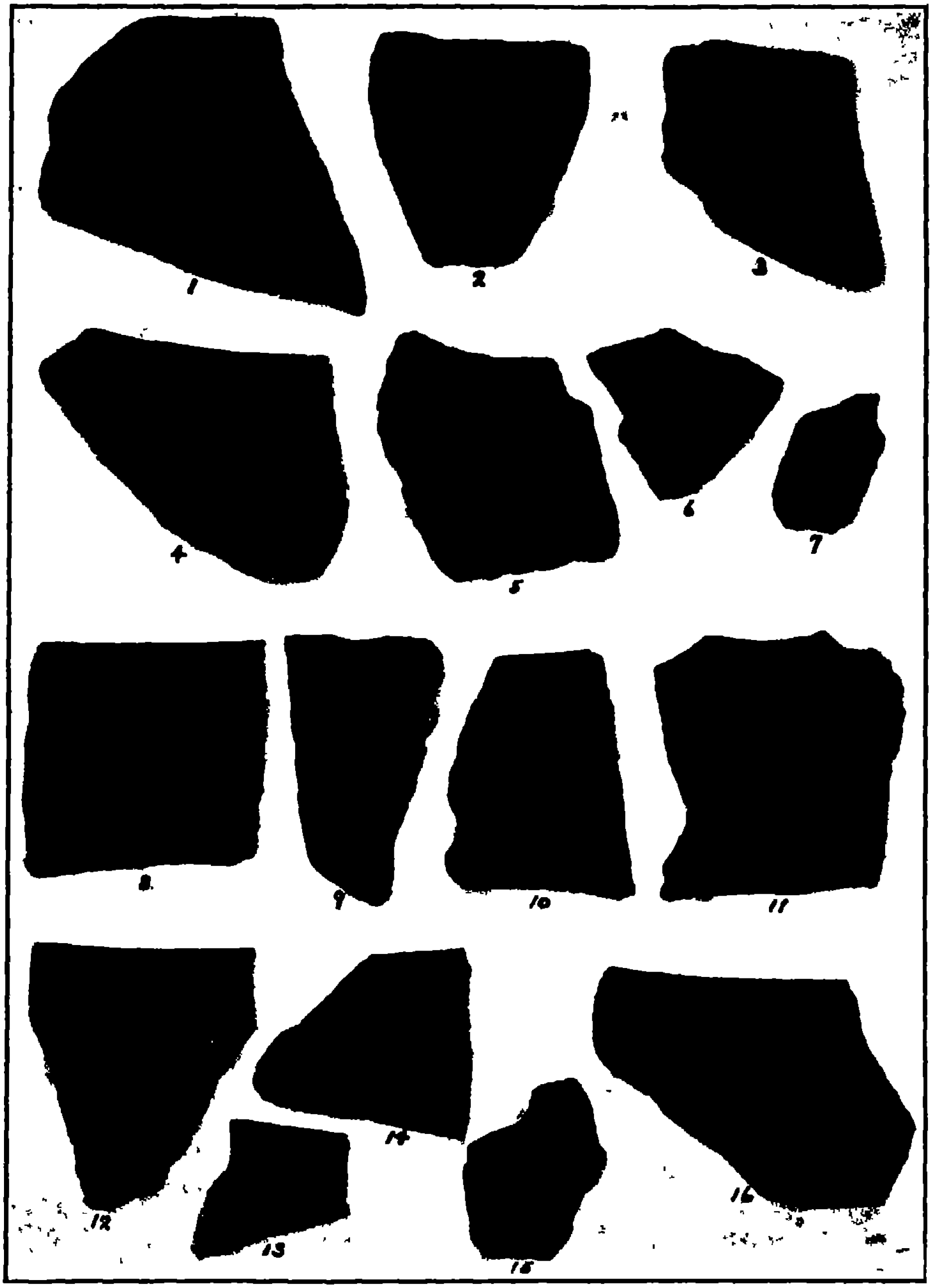
[2] *Archeological and anthropometrical work in Mississippi.* Smithsonian Misc. Coll. 78 (1). 1926.

[3] *Bernard Romans' map of 1772.* Publ. Miss. Hist Soc. 6: 415–439.

[4] In Mississippi Department of Archives and History and in Manuscript Division of the Library of Congress.



Figs. 1–7. Potsherds from site of Chickachae, old Choctaw village in northeastern Clarke Co., Miss. Figs 8–16 Potsherds from site of Ponta, Northern Lauderdale Co., Miss.

accompanying report of Capt. Bernard Romans, dated 1772, based on his exploration of the Choctaw country for the English colonial government during the preceding year. It was principally by means of the Romans map that Prof. Halbert, with his intimate knowledge of the geography and early history of the region, was able to locate the sites of many of the old Choctaw villages.

The pottery from these two sites, of which typical decorated pieces are shown in the plate, is of a hard uniform texture and is usually tempered with sand so fine that it can hardly be detected by the unaided eye. Both inner and outer surfaces are smooth and sometimes rather highly polished. In color the sherds range from light red and buff through gray into black, the largest proportion being buff or light gray. The color was usually produced by polishing the surface, merely intensifying the shade to which the firing had brought the clay. A few sherds, however, most of them from Chickachae, have received a slip of light brick red on both surfaces.

Little can be learned from the sherds as to the original form of the vessels except that most of them appear to have been bowls of medium depth.

The preponderance of decorated rims and the corresponding scarcity of rims among the many plain pieces suggests that the decoration was largely confined to the upper part of the vessel. As may be seen from the plate, this decoration, which is the most important and characteristic feature of the pottery, consists of straight or curved bands made of finely incised parallel lines. These bands, formed usually by five or six lines, range in width from about 5 to 10 millimeters. The uniform distance between the lines, as well as their uniform depth, shows that they were made by trailing a fine, comb-like implement across the surface of the vessel while it was still soft. Among the 118 decorated sherds of this type from Ponta, there are fewer than half a dozen in which the lines seem to have been drawn free hand. The lot of 67 similar sherds from Chickachae shows a slightly larger proportion on which the lines are somewhat irregular. The bands on the majority of sherds from Chickachae are also a little broader than those from Ponta, the average width being between 8 and 9 millimeters as compared with about 6 millimeters for the Ponta pieces, and the lines composing them are likewise somewhat deeper. With these slight variations, however, the ware from the two sites is identical.

No other well defined ceramic type is represented in the potsherds from Ponta and Chickachae. Less than 20 sherds from these two sites bear decorations other than of the type described: these few are of cruder ware and are meagerly ornamented with irregular incised lines. There is, in addition, comparatively little undecorated ware of a cruder type; the greater part of the plain sherds, of which there are many, are of the same smooth compact ware as the decorated pieces.

The potsherds from Chickachae and Ponta represent the only adequate samples that were obtained. Very scanty collections of sherds were picked up on the sites of Yowanne in Wayne County, Okhata talaya in Newton County, and Halunlawasha in Neshoba County, and yet among the handful of sherds thus obtained one or more of the banded type was found at each of the three places.

The presence of this single type of decorated ware from such widely separated Choctaw settlements, covering the entire area known to have been occupied by that tribe, suggests very strongly that it was the prevailing type of pottery in use at some period of their history. It may safely be regarded as historic, in the sense that it is found thus far only at Choctaw sites known to have been occupied as late as the 19th century, but further than this its age cannot at present be determined.

In texture and color this Choctaw pottery is similar to a widespread type from the mounds in western and central Mississippi and in parts of Arkansas and Louisiana. It is strikingly different, however, from the prevailing type of mound pottery from eastern Mississippi. The pottery from the mounds of this section is usually rough and crumbly and contains rather coarse tempering material. The decorations most often found are produced either by "brushing" or by impressing cords or coarse fabrics on the soft surface. Sometimes there is an ornamentation consisting of carelessly incised lines or punctations, and, infrequently, of the stamped curvilinear designs so common in Georgia and Florida.

It is too early to speculate, on the basis of this ceramic distribution, as to whether this Choctaw pottery developed locally or whether it had its origin to the west. Consideration of this question, as well as that of a possible earlier occupancy of the Choctaw territory by some other tribe, must be deferred until more complete information is available. It would be very desirable, for this purpose, to have additional collections of potsherds from other known Choctaw village sites and from the little known mounds and unidentified sites of central and western Mississippi.

RADIOTELEGRAPHY.—*Experimental confirmation of the influence of a low-resistivity layer subsoil on the forward inclination of radio waves.*

J. E. I. Cairns, Watheroo Magnetic Observatory, Department of Terrestrial Magnetism, Carnegie Institution of Washington. (Communicated by Louis A. Bauer.)

On the conclusion of the resistivity-survey of the region about the Watheroo Magnetic Observatory, at the end of June 1926, it was seen that the characteristics of the terrain were such as to afford means of experimental confirmation, or otherwise, of the suggestion, first put forward by Hack,[1] that ground-water (or a low-resistivity layer), at a depth of a fraction of a wave-length below the ground-surface, would almost entirely annul the "forward" inclination experienced by radio waves when travelling over ground of considerable resistivity. The survey at Watheroo showed the surface layer, down to depths varying from 5 to 10 meters, of the sand-plain which comprises the greater part of the surrounding country, to be of very high mean resistivity, falling off rapidly below this surface layer to value less than one-tenth per cent of that at the surface at depths of 60 meters in most cases. At one place, about 2 miles east of the Observatory, the low-resistivity layer breaks through to the surface, the resistivity down to 100 meters being less than 400 ohms per centimeter cube.

Thus the conditions were admirably suitable. Although Hack had shown previously that the inclination would be annulled, measurements of resistivity of undisturbed soil were not at that time available. These measurements, at Watheroo were made at low frequency (approximately 60 cycles), and the results are accurate to within one per cent.[2]

Two sites only were selected for the measurements, namely, at the places of highest and lowest resistivities, respectively, upon the conclusion of the survey. The highest was at the mid-point of the "survey line *P*" about three-quarters mile due north of the Observatory, and had a mean value down to 5 meters depth of approximately, 1,500,000 ohms per centimeter cube. The point of lowest resistivity was selected principally to test the accuracy of the apparatus, since it was of such low value down to a depth of 100 meters, that the inclination must have been negligible. The variations of resistivity with depth at the point *P* and for mid-point of section *e*, line 2 (the low-resistivity spot) are given in Table 1. At *P* the ground sloped

[1] J. Zenneck, *Wireless Telegraphy* (English Translation), pp. 260–262, 1915.

[2] L. H Gish and W. J. Rooney, Terr Mag, 30, 161–188, 1925.

backwards towards the transmitter at an angle of about one-quarter degree (measured roughly with a theodolite), while at section *e*, line 2, the surface sloped away from the transmitter at an angle of 1.3 degree. Observations were made on one station only, 6*WF* (wave length 1,250 meters), since the times of transmission from this station were definitely known. The Observatory is almost exactly due north of the transmitter, and 132 miles from it.

TABLE 1.—VARIATIONS OF MEAN RESISTIVITY WITH DEPTHS AT WATHEROO MAGNETIC OBSERVATORY

DEPTH	MEAN RESISTIVITY FOR POINT	
	P	Mid-point section *e*, line 2
m	*ohms per cm cube*	*ohms per cm cube*
2.5	1,016,000	351
5	1,417,000	236
10	954,500	205
20	214,000	223
30	35,000	224
60	1,480	256
100		310

APPARATUS

The apparatus consisted of a portable Hertzian rod oscillator, mounted on the telescope of a theodolite, and connected to a screened five-valve receiver by leads passing through a thick iron tube. The rod was 7 feet above ground when set up for measurements. The rod consisted of two five-foot lengths of thin wood joined by ebonite strips and stayed at the ends by strings passing to a king-post at the center. Upon the rod, the wire forming the aerial was strained, and tied at intervals with thread to prevent movement relative to the rod itself. The straining of the rod introduced a slight bend, thus inserting a small component of the oscillator normal to its length, the means for eliminating the effect of this are described below. The screening was effective enough to reduce the stray pick-up to zero, and the effects due to the unsymmetrical capacities of the individual halves of the rod were reduced considerably by means of a partial ground to the mid-point of the oscillator-system, as described by Greenleaf W. Pickard.[3] The oscillator was mounted on the top of the screening box containing the receiver, and the observer stood on another box at the center, immediately opposite to the lead-in tube. The ground was cleared for a distance of at least 15 feet all round the point where observations were being made. The receiver was caused to oscillate, thus giving a heterodyne note with the carrier of the received wave. The circuit employed is shown in Figure 1.

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[3] GREENLEAF W PICKARD, The Polarisation of Radio Waves, Inst. Radio Engineers, 1925.

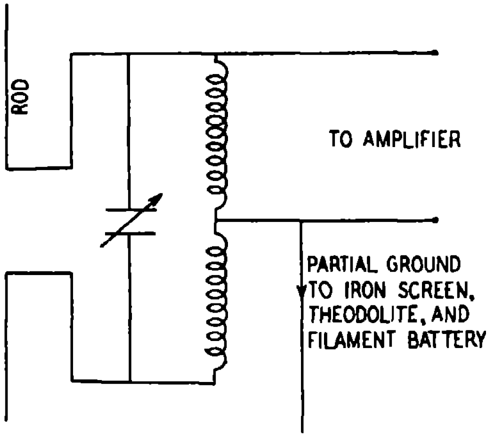
ROD
TO AMPLIFIER
PARTIAL GROUND TO IRON SCREEN, THEODOLITE, AND FILAMENT BATTERY

Fig 1.—Diagrammatic sketch of set-up

METHOD OF OBSERVATION

The two halves of the oscillator were not in the same straight line, so that the procedure for observation had to be devised to eliminate the effect due to the fixed component of the rod normal to its length. A short length of the leads also, about 3 inches, was unscreened, so that the procedure had to include means for eliminating the pick-up which these introduced. One side of the rod was marked *Up*, the other *Down*, one lead was marked *N*, and when *N* was connected to the north terminal of the rod, the arrangement was termed *Position A*; when *N* was connected to the south terminal, the arrangement was called *Position B*. The schedule for a single observation then was:

(I) Rod *Up*—(1) position *A*, vertical circle east; (2) position *B*, vertical circle east; (3) position *B*, vertical circle west; (4) position *A*, vertical circle west.

(II) Rod *Down*—(1) position *A*, vertical circle west; (2) position *B*, vertical circle west; (3) position *B*, vertical circle east; (4) position *A*, vertical circle east.

By this method of complete reversal, the results should be free from the spurious effects due to imperfections in the oscillator and lack of symmetry, stray pick-up, and incorrect setting of the horizontal circle on the bearing of the transmitter. In the case of the observations at P, 20 readings were made for each combination, to obtain a fairly reliable mean, then 20 on the next, and so forth. A slightly variable factor was introduced by the wind, which during both sets of readings was blowing from the west, and causing the rod to vibrate considerably. This caused, on occasions, a noticeable blurring of the minima.

TABLE 2.—RESULTS OF OBSERVATIONS AT WATHEROO MAGNETIC OBSERVATORY ON STATION 6WF TRANSMITTING AT WAVE-LENGTH 1,250 METERS

LOCATION	ROD, POSITION, VERTICAL CIRCLE	NO. OF OBS'NS	INCLINATION	INCL'N TO VERTICAL	TRANSMISSION	GROUND LEVEL	INCL'N TO SURFACE
			°	°		°	°
Res.-survey line P	*Up, A, E*	20	+7.6	−0.6	Night	+0.2	−0.4
	Up, B, E	20	−7.2				
	Up, B, W	20	−9.6				
	Up, A, W	20	+6.6				
	Down, A, W	20	+8.6				
	Down, B, W	20	−7.6				
	Down, B, E	20	−9.5				
	Down, A, E	20	+6.6				
Middle section *c*, res.-survey line 2	*Up, A, E*	10	+6.8	+0.6	Day	+1.3	−0.7
	Up, B, E	10	−8.1				
	Up, B, W	10	−8.2				
	Up, A, W	10	+10.1				
	Down, A, W	10	+11.3				
	Down, B, W	10	−5.6				
	Down, B, E	10	−9.4				
	Down, A, E	10	+7.7				

It is shown[4] that the ratio of the horizontal to the vertical-electric force, on Zenneck's theory, is given by the formula

$$\frac{E}{X} = \sqrt{\frac{m}{\sqrt{1+m_1^2}}} = \tan\beta \qquad (1)$$

where $m = nk\,\rho/2 \times 10^{11}$, $m_1 = nk_1\,\rho/2 \times 10^{11}$, and n = frequency, k = dielectric constant of air, k^1 = dielectric constant of the soil, ρ = resistivity in ohms per centimeter cube, and β = the angle of the forward inclination of the wave-front to the normal. When the rod makes the same angle with the horizontal as the wave-front does with the normal to the ground, no sound is heard in the telephones. The rod was rotated, therefore, about its horizontal axis, with its long axis normal to the wave-front, until a minimum was heard.

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[4] J. A. FLEMING, *The Principles of Electric Wave Telegraphy and Telephony*, 4th edition, 1919.

RESULTS OF OBSERVATIONS

The results of the observations are shown in Table 2. The maximum departure from the mean of the readings in any one set was 4°, and that on one occasion only. In general, the departures were 2° or less, and the mean may be taken as accurate to 1°.

DISCUSSION OF RESULTS

In each case, the resultant inclination to the ground normal is seen to be negative, and this, if real, is most probably due to two causes: (1) The vibration of the rod caused by the wind; and (2) the fact that the minima in the positions giving negative inclination were sharper than in the positive positions. In any case, the resultant inclination is less than the accuracy of the mean readings, and it may be taken, therefore, that it is either zero or negligible. From an inspection of Figure 2, which is plotted from values computed according to formula (1), assuming a value for the dielectric constant of the soil as 2 (the value of k_1 has little effect on the value for tan β), it will be seen that if the surface layer alone were concerned in the conduction of the wave, an inclination of the order of 20° should have been observed at P and none at all at section e, line 2. From the circumstance that

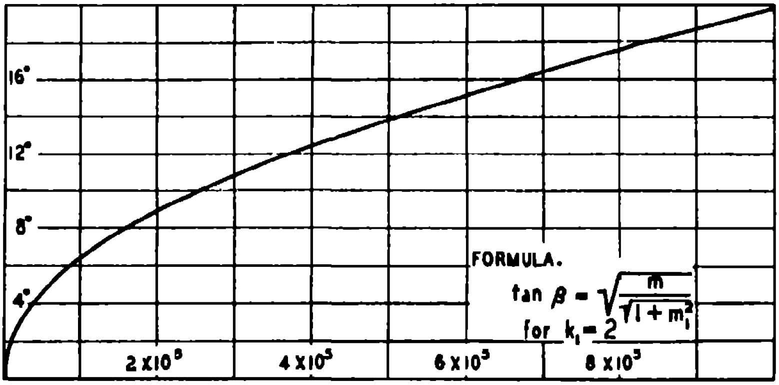

Fig. 2—Plot of wave-front angle of forward inclination in degrees for wave-length = 1250 meters against resistivity in ohms per centimeter cube

no inclination was observed in either instance, it is evident that the low-resistivity layer below the surface is sufficient to entirely annul the forward inclination of radio waves, at least those of wave-length 1,250 meters. Moreover, from Table 1, it may be deduced that the mean depth to which waves of this wave-length penetrate, is at least 45 meters, for at that depth, the mean resistivity at P is such as to give a forward inclination of 1°.

SUMMARY

Over soil, the mean resistivity of which had been measured *in situ* down to depths of 60 to 100 meters, and which consisted of a layer of sand of an exceptionally high resistivity over a layer at no considerable depth of very low resistivity, radio waves of wave-length 1,250 meters were found to experience no forward inclination. This is regarded as being more definite proof than has hitherto been given of the effect of ground-water or a low-resistivity layer a short distance below the surface, owing to the greater precision of the resistivity measurements of the undisturbed soil.

I wish to express appreciation of the interest shown and the facilities given by Mr H. F. Johnston, Observer-in-Charge at the Watheroo Magnetic Observatory; also thanks to Observer Mr. F. W. Wood for material assistance in transporting apparatus and recording, and to Mr. W. J. Rooney, who made the resistivity-survey of the region for the resistivity-values at the two points of observation in advance of publication.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

948TH MEETING

The 948th meeting was held at the Cosmos Club, January 8, 1927. The address of the evening was given by the retiring president, WILLIAM BOWIE, on *The part played by isostasy in geophysics and geology*. (Published in the JOURNAL, 17. 101-117, March 4, 1927)

949TH MEETING

949th meeting was held at the Cosmos Club, January 22, 1927

Program: R. L. SANFORD, *The problem of magnetic analysis*. The idea that the magnetic properties of iron and steel can be used as criteria of their mechanical properties has been the subject of speculation and experiment for more than forty years. In view of the fact that the application of this idea, which has been termed magnetic analysis, is still in the experimental stage, it seems desirable to consider what progress has been made, to ask ourselves whether further effort is justified, and, if so, along what line investigation should be directed.

New testing methods have been developed, making possible much investigational work that otherwise could not have been done. The large mass of data which has been obtained indicates a close connection between the magnetic and mechanical properties of steel.

No positive evidence has yet been obtained to controvert the idea that there is a definite relation between magnetic and mechanical properties, and in view of the great need for a practical method for the nondestructive testing of iron and steel and their products further effort in this field appears to be amply justified.

Main attention should be given to fundamental investigation because it is necessary to know the underlying principles in order to realize to the fullest extent the possibilities of magnetic analysis. The greatest obstacle at present is the effect of mechanical strain. Mechanical and magnetic properties are both modified by strain, but not necessarily to a corresponding degree and this factor must be eliminated or evaluated before the fundamental relationships can be discovered. If this can be done the practical application should be a relatively simple matter. (*Author's abstract*)

The paper was discussed by Messrs. WHITE AND HUMPHREYS.

P. R. HEYL, *The constant of gravitation.* The Bureau of Standards has had under way for the past three years a redetermination of the Newtonian constant of gravitation, the quantity k in the formula for the force of attraction between two bodies

$$\text{Force} = \frac{kMn}{D^2}$$

The method used was that of the Cavendish torsion balance, set up in a vacuum. The large attracting masses were placed in two positions, at right angles, and the difference in the time of swing noted. This amounted to about five and a half minutes. The last experimenter who used this method (Karl Braun, 1896) obtained a difference of only about three quarters of a minute.

The programme of observations has been finished, but the calculations are not yet completed It is expected that the results will be ready to announce in a couple of months (*Author's abstract*).

The paper was discussed by Messrs. BREIT, WHITE, CURTIS, DRYDEN, PRIEST, WADLEIGH AND CROOK.

H E MERWIN, *Recording Secretary.*

THE GEOLOGICAL SOCIETY

427TH MEETING

The 427th meeting was held at the Cosmos Club, March 9, 1927, President BUTTS presiding.

Informal communication: HUGH D. MISER: *Shapes of stream pebbles in San Juan County, Utah.* The question, "Do stream pebbles have any characteristic shape?," has been asked by many geologists. On this question

I here record briefly my observations in the canyon of San Juan River, Utah, in 1921.

Pebbles of many kinds of rocks, including sedimentary and crystalline rocks, and vein materials, constitute the gravel deposits on widely scattered benches in the canyon. The deposits occur at several different levels up to 600 feet above the river, and consist largely of pebbles that have been derived from pre-Cambrian and later rocks in the San Juan Mountains of southwestern Colorado. The pebbles from these mountains have been transported by streams for distances that range from 200 to more than 300 miles Their shapes, as well as the shapes of the pebbles that are derived from the rocks along or near the Canyon, are the result of stream wear Such wear is of course influenced by the nature and structure of the pebbles, and the shape of the original rock fragments

The pebbles are mostly 1 to 3 inches in diameter and most of them are well rounded. The well rounded pebbles consist of quartzite, limestone, gneiss, schist, sandstone, conglomerate, vein quartz, porphyritic igneous rocks, and granitoid igneous rocks Also the well rounded pebbles contain a considerable proportion of flattened ellipsoids rather than spheres or flattened spheroids. Many platy rocks such as schist and laminated sandstone naturally break into flat fragments and readily yield flattened pebbles when the corners are rounded off Homogeneous rocks such as granite, andesite and vein quartz might be expected to yield some spherical pebbles, but not a single sphere was observed by me. All pebbles of these and other kinds of homogeneous rocks are flattened The flattened ellipsoidal form of the pebbles may be due to the original shape of the rock fragments, none of which would likely have equal dimensions as does a cube.

Pebbles that are not well rounded include flint, agate, and chalcedony. I believe their brittleness and also their great hardness are factors that influence their shapes. I believe they may break into large and small fragments at times during their life history.

Many subangular pebbles are bounded by facets which were formed by the breaking of the rock along laminae or other weak planes. Wind-faceted pebbles were not noted by me but some pebbles, especially those of limestone, were furrowed with minute grooves that were produced by sand blasts in the few small areas of dune sand. (*Author's abstract*)

Program· W. P. WOODRING and P. V ROUNDY: *Geology and oil development of the Elk Hills, California* The Elk Hills lie along the southwest edge of the San Joaquin Valley in the outer belt of foothills of the Temblor Range. The only outcropping beds are late Pliocene nonmarine deposits called the Tulare formation. They consist of alternating beds of sand and clay. The sand is clean and arkosic, cross-bedded, and has a complex pattern of gravel courses The clay is silty and massively bedded, and carries calcareous layers ranging even in the same layer from calcareous clay to limestone The sands are alluvial fan deposits and the clays seem to be mud-flat and playa deposits. The alternation of these beds at any one place is so perfect and on so large a scale that it demands some kind of periodic control and probably the simplest kind of periodic control is periodic subsidence of the San Joaquin Valley. The oil-bearing beds lie in the upper part of the Etchegoin formation, which underlies the Tulare formation Immediately above the main oil zone and lying in nonmarine beds is a thin layer carrying some curious fossils, known as *Scalez petrolia*. These fossils are calcareous opercula of freshwater snails similar to living pond snails of the genus *Viviparus*, which, however, have horny opercula. The *Scalez*-bearing bed is a very reliable datum plane and is used to great advantage by the oil operators.

Structurally the Elk Hills consist of two main gently folded anticlines. Narrow steeply folded anticlines lie along or near the south edge of the hills and also at the northwest edge. These little anticlines probable are very shallow and in some way are the offspring of the main folds, but their origin is not clear.

The main oil zone of the eastern part of the field lies immediately below the *Scalez*-bearing bed. The gas produced in the central part of the field is obtained from beds above this zone. Contours drawn on the *Scalez*-bearing bed show that the dip of the oil-bearing beds is twice as great as the dip of the surface beds. Faults that have a maximum stratigraphic displacement of about 250 feet at the horizon of the oil-bearing beds have not been recognized at the surface. During the last 6½ years the field has produced more than 76,000,000 barrels of oil. (*Authors' abstract.*)

Charles W. Gilmore: *Fossil footprints in the Grand Canyon.* Two trips to the Grand Canyon, Arizona, were undertaken for the dual purpose of securing collections of fossil tracks for the U S National Museum and preparing an exhibit *in situ* for the National Park Service

The tracks occur in the Coconino, Hermit, and Supai formations at levels of 1,000, 1,300 and 1760 feet, respectively, below the present rim of the Canyon wall Both of the projects were successfully carried out, a collection of slabs of footprints some 4,400 pounds in weight were secured for the National collections and a track-covered surface several hundred square feet in area was uncovered by the side of the Hermit Trail in the Coconino sandstone to form a permanent exhibit of the tracks as they occur in nature.

All of the tracks in the Coconino occur on the inclined surfaces of the strong cross-bedding of the sandstone, and all but three of the hundreds of tracks and trails observed were headed up the slope No satisfactory explanation of this fact has yet been obtained

Adequate ichnite faunas have now been established for the Coconino and Hermit, and a beginning made on a fauna for the older Supai. In all, 24 genera and 33 species of fossil tracks have now been recognized, distributed as follows: Coconino, 15 genera and 22 species, Hermit, 6 genera and 8 species; Supai, 3 genera and 3 species. Comparison of these faunas shows them to be absolutely distinct from one another as not a single genus is common to any two of the faunas. Both vertebrate and invertebrate animals are represented by these tracks No skeletal remains have yet been found in the Grand Canyon and consequently no direct evidence can be offered as to the makers of any of these tracks. (*Author's abstract.*)

Raymond C Moore: *Problems in the History of the Grand Canyon Region.* The unparalleled vertical and horizontal extent of rock exposures in the Grand Canyon region and the clearness with which phenomena relating to almost all branches of geology are represented, have made this territory a classic ground for studies in geologic science. Yet, because of inaccessibility, observations have been essentially confined to a small part of the district. Indeed, excepting John Wesley Powell, the writer is the first geologist who has had opportunity to visit parts of the upper and lower sections of the canyon.

Notwithstanding excellent exposures and the more or less detailed observations of various workers, it is expectable that there are many unsolved problems in the geologic history of the Grand Canyon region. These may be arranged conveniently in groups: (*a*) those of the stratified rocks, their age, origin, relations to associated formations, regional relations, and the significance of various minor characters; (*b*) those of the igneous rocks, intrusive and extrusive; (*c*) those of the metamorphic rocks, their classification and origin, (*d*) those bearing on the structure of the rocks, its origin, geologic age and effects; and (*e*) those in the field of physiography. Only a few of these problems can be indicated here.

(*a*) The *stratified rocks* include about 4,000 feet of sub-horizontal limestone, sandstone and shale of Paleozoic age, resting unconformably on 12,000 feet of somewhat evenly inclined Proterozoic strata and on Archeozoic rocks. The regional relationships of the Kaibab limestone and Coconino sandstone at the top of the column, the nature and significance of the contact between these formations, and the origin of the Coconino are important problems The complementary variations in thickness of the Coconino and subjacent Hermit shale, the time represented by the unconformity at the base of the Hermit, the position of the Pennsylvanian-Permian boundary, and the stratigraphic relationships of the Devonian and of the Cambrian formations are largely unsolved problems. The remarkably smooth surface of the pre-Paleozoic rocks beneath the Cambrian, and of Archeozoic rocks beneath the Unkar series, suggests marine planation, possibly supplementing subaerial peneplanation.

(*b*) The *igneous rocks* include great and small intrusive masses of acid, intermediate, and basic rocks in the Archeozoic, mainly basic intrusive and eruptive rocks in the Proterozoic, and basic eruptives of Tertiary and Recent age. The many miles of continuous exposures of Archeozoic igneous rocks afford splendid opportunity for study that is almost untouched. The occurrence in each of the Proterozoic areas of thick diabase sills near the base of the Unkar series recalls the widespread similar rocks in the Proterozoic of other areas and in the Triassic Newark series The wide geographic distribution and persistence in stratigraphic position of the Grand Canyon diabase call for notice. In comparatively recent time basaltic lava invaded the canyon near Lava Falls, below the mouth of Havasu Creek, and flowed downstream at least seventy miles. Numerous remnants of the narrow canyon-bottom lava flow are found, with even upper surface a little over 100 feet above present river level. The results of temporary damming of the river and the length of the attenuated basaltic flow are interesting subjects of investigation.

(*c*) The *metamorphic rocks* of the Archeozoic have been classed together under the term Vishnu schist. Very much of the schist is undoubtedly of sedimentary origin; in parts of the canyon there are great thicknesses of little altered quartzite and slate. Several types of meta-igneous rocks are found. The differentiation of the Archeozoic complex offers several important problems.

(*d*) The *structure* of the rocks in the Grand Canyon region affords many subjects for study. The structure of the Archeozoic and Proterozoic rocks and its regional relations, the sharp monoclinal folds of post-Cretaceous-pre-Eocene age, the large normal faults of post-Wasatch (Eocene) age; the movements at certain places at different geologic times, in some cases in opposite directions; and the nature, time and causes of regional warping are some of these problems.

(*e*) The *physiography* of the canyon country has long been an alluring field for research, and observations in this region have helped to clarify various physiographic concepts. The relation of land forms to rock hardness and structure is evident, though the development of some of the characteristic features, such as the amphitheaters, the long narrow spurs and the general pattern of sculpture in parts of the Grand Canyon, have not been obvious. The writer accords with the conclusion of Noble and Matthes that small faults and comparatively unnoticed fractures have played an important rôle in the shaping of the canyon. However, the origin of the canyon as a whole, the location of the course of the river, and the physiographic history of the region offer problems that are largely unsolved. Remnants of peneplains, intrenched meanders and other features bear testimony to a long and probably complex history. The writer's study leads to the conclusion that much erosion in the Grand Canyon area, involving removal of most of the Mesozoic rocks that were once present here, was probably accomplished in pre-Wasatch time; that the river was established in its present course mainly by superposition, following a course that was consequent on Tertiary beds; and that the main stream is influenced by structure near the south end of the Kaibab Plateau, between Diamond Creek and the mouth of the canyon, and perhaps at other places, but seems to be unrelated to the great Tertiary faults which cross the region Study of Glen Canyon, Marble Gorge, and adjacent parts of the plateau country suggests the existence of a well advanced erosion cycle which was interrupted at a stage when the river had already begun the excavation of the Grand Canyon and had cut downward more than 2,000 feet below the Kaibab rim Perhaps this earlier erosion cycle corresponds to the "Great Denudation" of Dutton that preceded the stage of active canyon cutting While the sudden widening of the canyon in the Kaibab division may result from the beginning of erosion here in the earlier erosion cycle, the writer knows of no identifiable remnant of the suggested pre-canyon cycle within the Grand Canyon. Such platforms as the Tonto bench and the Esplanade are structural in origin It is doubtful whether any remnants of an older valley could be preserved where subsequent downward erosion has been so active

The distribution of rapids, in almost every case at the mouth of a tributary stream, and the relation of river gradient to rock hardness and other factors of stream erosion are interesting subjects of study. One may conclude that despite numerous rapids, a certain more or less stable relationship has been attained on Colorado River between the rate of erosion and the ability of the river to erode. (*Author's abstract.*)

428TH MEETING

The 428th meeting was held at the Cosmos Club March 23, 1927, President BUTTS presiding. *Program:* T. B. NOLAN. *Potash brines underlying Great Salt Lake Desert, Utah.* During the summer of 1925, the Geological Survey, in cooperation with the Bureau of Mines and the General Land Office, prospected the potash-bearing brines in the Great Salt Lake Desert region. Two types of brine were found. (1) brine contained in the interstices of crystalline salt deposits, and (2) brine found at a definite horizon in clays belonging to the Lake Bonneville beds. The first type of brine is the more concentrated of the two and is believed to represent a residual mother liquor, more or less modified by rain water, that has existed since the final withdrawal of the waters of Lake Bonneville The horizon at which the second type of brine occurs is thought to be a salt-impregnated zone deposited during the final stage of the earlier desiccation of Lake Bonneville, and would thus be equivalent to the unconformity found by Gilbert between the Yellow Clay and the White Marl. The brine found is considered as being the result of the introduction of surface drainage waters along this soluble layer This hypothesis is based upon the following observations: The depth to the brine horizon is a minimum at the center of the Desert and increases to 9 feet at the edge of the prospected area. This compares with a thickness of 10 feet for the White Marl in the type section at the Old River Bed. The clays above and below the brine horizon are sufficiently impermeable that towards the center of the area, where the brines are under a hydrostatic head, a rise of as much as a foot results when the horizon is tapped by a bore hole. Obviously, the brine horizon has some property not possessed by the remainder of the clay. The concentration of sodium chloride in the brine increases towards the center of the area, and the rate of increase was found to vary inversely with the amount of surface drainage waters available Thus, where large drainage channels enter the prospected region, the chlorine content is notably depressed. Further, the relative amounts of potassium and magnesium in the brine show a striking dependence upon the character of the country rock in the adjacent highlands— potash, for example, being high in the brines where rhyolite flows from the highlands nearby, and magnesium tending to dominate near areas of dolomitic rocks The calcium sulphate and carbonate, which presumably formed a large part of the mineral content of the indraining surface waters, have been almost entirely precipitated and are represented by a "caliche" or hardpan immediately above the brine horizon.

Deep bore holes put down by one of the operating companies showed the presence of several deeper brine horizons. If these may be interpreted in the same manner as the one prospected, it would seem that the history of the Bonneville Basin is considerably more extensive than has been so far recognized. (*Author's abstract*)

C K. WENTWORTH, J E. HOFFMEISTER, AND H S. LADD: *Unusual types of sediments from Pacific Islands* Four types of islands are represented in this study · (1) oceanic islands of volcanic origin such as the Hawaiian groups, (2) oceanic islands without known igneous base such as the coral islands of the Line and Tonga groups; (3) islands like Eua, Tonga, which have a volcanic ash base nearly entirely covered with limestone; and (4) islands like Vitilevu, Fiji, which are partly volcanic but have some continental types of rocks

(1) In Hawaii the sediments are derived mainly by chemical weathering from basalt and consist of highly ferruginous mantlerock and soil, gravel and ferruginous clays with very little sand; coral reef rock; detrital calcareous sand composed of coral, shell and foraminiferal debris, and pyroclastic rocks and their crystal sand derivatives.

(2) The sediments of the Line Islands, which are wholly of organic origin, are chiefly coral and *Tridacna* gravels and conglomerates; beach sands of coral and molluscan shell debris and foraminifera; and coral muds and silts. Reef formations are the fundamental rocks of the group and the source of the detrital derivatives

(3) The island of Eua is a representative of the Tongan group. The core of the island is volcanic tuff. This is overlain by younger sediments of various sorts, including a reworked tuff to which much organic material has been added. Foraminiferal and coralline limestones form an extensive series of terraces, and in one locality andesite boulders in a matrix of calcareous sand form a thick deposit of conglomerate.

(4) The dominant sediments of Vitilevu, Fiji, are those belonging to the agglomerate-tuff-marl series, most of which are marine in origin. The marls are usually reworked tuffs to which variable amounts of clay and shelly material have been added Subordinate rock types include conglomerates, sandstones, and limestones of several sorts, often more or less tuffaceous. Both foraminiferal and coralline limestones occur. Ordinarily these are found as small lenticular bodies in the main series, but two limestone masses, each several hundred feet in thickness, are known. (*Authors' abstract.*)

W. C. ALDEN: *Certain Pliocene and Pleistocene features of Yellowstone Park and its environs.*

W P. WOODRING, W. W. RUBEY, *Secretaries.*

SCIENTIFIC NOTES AND NEWS

Members of the United States Geological Survey on May 2 tendered Dr. GEORGE OTIS SMITH a testimonial luncheon in honor of his completion of 20 years as Director Dr SMITH became a member of the Survey in 1896 and was appointed Director in 1907

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GEOLOGY.—*A Review of recent reports on investigations made in Florida on Pleistocene geology and paleontology.*[1] OLIVER P. HAY, Washington, D. C.

Recently the writer presented a paper[2] which dealt with the geological age of the vertebrate fossils reported as found by Professor F. B. Loomis and Dr. J. W. Gidley, mostly at Melbourne, Florida. Since the presentation of that article other reports on investigations at Melbourne, Vero, and one or two other localities have been published. One is a joint report[3] by Gidley and Loomis on their work done in 1925. Another is an individual statement made[4] by Prof. Loomis. A third report is that made[5] by Dr. Wythe Cooke, who was assigned by the U. S. Geological Survey as associate with Dr. Gidley in the investigation made in 1926. Dr. Gidley's report for work done in 1926 has not yet appeared. In the statements published the writers describe the geological features of the various localities, note in a general way the fossils found, and announce the conclusions reached concerning the age of the deposits and fossil animals and that of the human remains encountered.

It is not wholly a pleasant task to take up this subject again and to employ the necessary repetitions. In various respects the reports are disappointing. On the geological side, one might expect to find a sketch map showing the topography of the region examined at Melbourne and the locations of the excavations made From the paleontologists the public might have expected a more satisfactory statement of the species of vertebrate fossils found As it is, only a few are mentioned and these only incidentally. Since the close of the work of 1926 nearly a year has passed and in this interval the fossils then collected might have been studied and their meaning determined. Dr. Cooke mentioned some fossils under names based on identifications made in the field by Dr. Gidley and often followed by marks of query. At present one can not be certain just what species were collected by the various expeditions nor in exactly what horizons they occurred.

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[1] Received February 3, 1927.

[2] This JOURNAL, 16: 387-392. 1926

[3] Amer Journ Sci (5), 12: 254-264 1926

[4] Nat Hist, 26: 260-262 1926

[5] Amer Journ Sci (5), 12: 441-452 1926

The writer will deal first with Dr. Cooke's report. With the details of this, little fault is found. Dr. Cooke was bound within narrow limits by his acceptance of the theory of marine origin of the terraces of the coastal plain and of the times of their formation. When he argues that, if those terraces were formed at long intervals during the Pleistocene, the lowest one is of rather recent date, he is right. If this were granted, it would follow that any deposits and fossils laid down on this terrace are young.

In one of his papers the writer, in discussing the coastal plain terraces, showed[6] that if they were of marine origin there must have been buried in each of them abundant remains of marine organisms, especially of mollusks. So far as known, such remains are wholly lacking, except in the lowest levels of the lowest terrace. When I inquire what agency has been effective in removing the vertebrate bones and teeth and the molluscan shells I am told that it has been done by carbonated rain water. This theory appears reasonable until it has been tested. Over large areas of Florida the shell bed of the Anastasia marl has been exposed long ages at or near the surface and it remains there. Rain water has not dissolved out the shells of mollusks and the bones of whales buried in the Pleistocene clays around Lake Champlain and along St. Lawrence and Ottawa rivers. Along Mississippi and Missouri rivers are thick deposits of loess, a formation permitting the easy passage of meteoric water. In many localities numerous species of delicate land snails remaining unchanged have been collected from it.

If we carry our investigations into Europe, where the Pleistocene has been more thoroughly studied than in America, we soon learn that around nearly all the countries bordered by seas there are marine deposits of Pleistocene age, often in the form of terraces. In the interior, beyond the reach of marine waters, along the rivers and lakes, both in glaciated and unglaciated regions, are terraces, sometimes as many as four or more, and belonging some to early and some to late Pleistocene times. These terraces show not only by their physiographic form but more convincingly by the inclusion of fossils that they were laid down under waters, marine or fresh, during times of subsidence. Believers in the marine origin of our coastal plain terraces ought to procure Haug's *Traité de Géologie* and read his remarks on the Quaternary. They might then wonder what has been the matter with the rain water which has fallen on European soils for the last half million years that the abundant fossils have not been dissolved out. An entire page could be filled by only the record of localities where fossils, especially mollusks, marine, freshwater, and terrestrial, are found.

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[6] This JOURNAL, 14: 255 1924.

The writer believes that he is justified in saying that the reason why no marine fossils are found on our coastal plain terraces is that marine waters have had nothing to do with those terraces. Probably not since the Pliocene has our coast, south of New Jersey, been submerged more than a very few feet. North of New Jersey there was, during at least the last glacial stage, considerable subsidence, and this is shown by an abundance of marine fossils.

There appears to be sufficient evidence that during the latter part of the Pliocene and during the earlier part of the Pleistocene the whole of this continent stood at a much higher level than it now does It seems not improbable that the eastern border of the continental shelf was near sea-level. It was probably during this time of high elevation that the swift and swollen streams excavated the gorges and canyons which are known to exist, but which are often in one way or another partially hidden. Examples of these are the wide and deep basins which contain most of the Great Lakes, the trough of St. Lawrence River, the extensive submarine trench which extends many miles out from the mouth of the Hudson, the broad and deep valley in which reposes Chesapeake Bay, the deep excavation, refilled apparently to as much as 1,200 feet,[7] in which the lower Mississippi flows. Apparently before the end of the first glacial stage our eastern coast had settled down to about its present level; and there is little evidence and little probability that since that early time the elevation has been much greater than at present. During the greater part of the Pleistocene, therefore, our coastal plain, from New Jersey to the Rio Grande, has been practically stable. In whatever way the terraces were produced, they came into existence during the time of that elevation; and

[7] Louisiana Geol. Survey Bull, 1: 43. 1905

at the time of the first interglacial stage the low Atlantic shore was ready to receive deposits containing the remains of the animals we now find there.

Consistent with his belief in the theory of the marine origin of the terraces, Dr. Cooke, of course, accepts the interpretation that the deposits and their fossil contents are relatively young. In their joint report Dr. Gidley and Professor Loomis take a similar view of the rather late age of the deposits and of the fossils. The present writer is unable, however, to determine what is the fundamental idea on which their conclusions are based—whether on the theory of marine terraces, the modern aspect of the fauna, or the presence of human remains. The language employed by them appears often rather indefinite, so that each reader can interpret it to suit himself. On page 263 of the joint report a number of geological changes are indicated, but whether these involved any considerable amount of movement or of time is left uncertain. Very few vertebrate fossils are recorded. Two or three species of elephants, varying in structure, habits, geological age, and regional distribution, are included under the vague name mammoth. In short, there is a contrast between the laxity of the argumentation and the assertiveness of the conclusion.

The authors, as shown in their report, are not clear as to the exact age of the bed no. 2 and its fossils, but state that it was "probably pre-Wisconsin." Nor are they certain that the human skull was not originally imbedded in no. 2. If it was, man may have been there in pre-Wisconsin times. Or, as they suggest, the skull may have been crushed and pressed into bed no. 2 by some heavy animal in the interval between bed no. 2 and bed no. 3– therefore, in "possibly early post-Pleistocene," which is, of course, the Recent. The effort is made to bring up the age of the deposit as near the present time as possible, but nowhere is there a reason offered why bed no. 2 may not be as old as the first interglacial, the Aftonian.

In the endeavor to advance bed no. 2 to a late time in the Pleistocene the writers must account for the large extinct fauna found in it. They think it possible "that at this time there was still living in Florida at least a remnant of the Pleistocene fauna, including the mammoth and the mastodon." The suggestion that some of the Pleistocene animals lived longer than others appears to be an attractive one, inasmuch as it is accepted by Dr. Cooke and by Gidley and Loomis. Now, this remnant must have been a pretty substantial one. The writer has estimated that 70 per cent of the species of bed no. 2 is extinct and 30 per cent is yet living, but the 70 per cent includes many species which became extinct after bed no. 2 was laid down. It is, therefore, not unlikely that the remnant living at the close of deposition of bed no. 2 amounted to half of the fossil species known from Florida. It is hard to understand what advantages the authors of the report gain by exploitation of this remnant. It is the other remnant, the one which appears no more after the deposition of bed no. 2, that is to be considered. We must determine when the saber-tooth tigers (*Smilodon*), the capabaras of bear-like size, *Elephas imperator*, the camels, the horses of two or three species, the giant armadillo (*Chlamytherium*), *Megatherium*, the glyptodonts, the gigantic tortoises, and various species of smaller chelonians ceased to exist. We must not conclude that camels lived on to a late stage of the Pleistocene simply because some of the bisons did, nor that *Elephas imperator* continued on to the early Recent because another "mammoth" may have done so.

In addition to the genera and species mentioned above there have been discovered at Peace Creek, Vero, Melbourne, and various other localities in Florida, mylodons, megalonyx, tapirs, peccaries, long-horned bisons, mastodons, the giant beaver (*Castoroides*), huge dogs, and tigers, besides the great bulk of the species, big and little, which inhabited Florida when Ponce de Leon arrived in search of the fountain of youth. Doubtless all of these had existed somewhere during, we will say, the first interglacial stage. From that time this host had marched abreast some hundreds of thousands of years, down, as we are told, to the "pre-Wisconsin" or even to the "post-Pleistocene." Few or none had fallen exhausted by the wayside; few or none had been destroyed by any hovering enemy; apparently there had occurred no internecine conflicts; and none of the beasts had suffered from the rigors of four glacial stages. Then, as if to announce the tardy arrival of man on the continent and to prepare his environment, nearly three-fourths of that multitude was destroyed suddenly and in as mysterious a way as was the army of Sennacharib.

I am told by Dr. Cooke that some vertebrate paleontologists think that there are more specific differences than I admit between the Pleistocene animals of Florida and those of the glaciated regions. This may be true, but in the present discussion, not very important. A certain elephant, regarded by myself as *Elephas imperator*, may be something else, but it lived with the other genera and species of bed no. 2 and disappeared with them. It is open to anybody to describe from the bones and teeth found in Florida as many new species as he may desire. These new species will be found mostly in bed no. 2 and, as I view the case, will add to the high percentage of extinct species found in it and confirm its antiquity. As Cooke, Gidley and Loomis interpret the case, all the new species will simply magnify the slaughter that occurred just preceding the alleged late advent of man.

Various persons attach importance to the idea that the Pleistocene animals survived longer in Florida than in the northern States because of its genial climate. These persons must assume that the environment of Florida is even now more favorable for mammalian animals than more northern countries. Apparently the climate preferred by musk-oxen and polar bears is that of the arctic regions; by existing sloths and anteaters, that of the hot tropics; by a great variety of other animals, that of the intervening spaces. These persons must assume further that, even if the climate remained genial during the glacial stages, the animals living there all continued to exist from the early Pleistocene to its close. Mammalian genera and species, quite unlike mollusks, are relatively short-lived. Climate is not the only condition that effects the existence of vertebrates. If for any reason vertebrates from other parts of the continent had invaded Florida in great numbers their intrusion would have led to competition for place and food, and some of the less hardy forms would have succumbed.

The climate of the southern States, however, was probably during each glacial stage less genial than during the interglacial stages. During one stage, probably the Kansan, walruses flourished on the present site of Charleston, South Carolina. In the collection of Mr. C. C. Pinckney, of Charleston, the writer found a milk-tooth of a species of moose closely related to the one now living. Leidy recognized the presence of a musk-ox at Natchez, Mississippi. In his report Dr. Cooke included among the animals exhumed from the bed no. 2, at Melbourne, a possible reindeer. Although the teeth were later identified as those of a young elk, the earlier identification did not appear incongruous either to the geologist or the paleontologist. The climate which was favorable for walruses, moose, musk-oxen and the elk, would not have appeared genial to all of the ground-sloths, the armadillos, glyptodonts, the saber-tooth tigers, the camels, and the huge tortoises, all of which had been accustomed to a semitropical environment.

If those who insist that during glacial stages the climate of Florida was little different from that of the present really understand Pleistocene meteorology, will they not tell us what happened about the time of the introduction of human beings that so many of the animals were swept away?

Naturally the age of bed no. 3 came up for decision by the investigators at Melbourne, and they appear to have found the problem easy of solution. It is assigned to the Recent; but the present writer finds no adequate reason presented. Dr. Cooke states that the freshness of the vegetable remains and of the mussel shells indicates that no very long time elapsed during this accumulation—a conclusion which will not stand investigation. According to Gidley and Loomis, the deposit is somewhat more recent than the appearance of man, which itself was possibly early post-Pleistocene, that is, Recent. No reason is offered why bed no. 3 may not be as old as the Illinoian glacial stage or the Kansan. Much is made of the erosion of bed no. 2, but it might, without any uplift, have been effected by increased rainfall during one glacial stage. The considerable changes of level postulated are assumptions. Apparently few fossils were found in bed no. 3 at Melbourne, probably because of local conditions. At Vero, fifty-two species of vertebrates were collected, of which nineteen were regarded as extinct. The writer is inclined to believe that any of the species that survived the extinction following the deposition of bed no 2 may yet be discovered in no. 3. In an effort to prove the late date of the bed no. 2, Prof. R. T. Chamberlin contended[8] some years ago that it passed apparently without interruption into bed no. 3. His arguments may fairly be used to show that this upper bed is older than he suspected. The stratum of muck must have accumulated with extreme slowness The upper portions may really belong to the Recent epoch; the lower portion to late and middle Pleistocene.

The present writer has little to say about Professor Loomis's personal article mentioned above. It appears to be a repudiation of portions of the joint report On some matters I believe he is right; on others, in error. To the writer it appears that the evidence presented by the three investigators shows that the human skull and some of the artifacts belonged originally in bed no. 2. If further digging from Melbourne to Vero should, as it has done so far, reveal human relics imbedded in this stratum, one would have to conclude either that it was their original resting place or that the proboscideans were animated by an intense dislike at seeing such objects lying around loose on the surface.

[8] Journ Geol, 25: 666-683 1917

BOTANY.—*Six new Convolvulaceae from Venezuela.*[1] H. PITTIER, Caracas, Venezuela.

Breweria mollis Pittier, sp. nov.

Scandens, caulibus virgatis, verruculosis, dense pubescentibus; foliis nervosis, modice petiolatis, petiolo tereti, tomentoso, laminis submembranaceis, ovalibus, basi rotundatis apicem versus sensim angustatis, obtusis, mucronatis, supra parce adpresse villosis costa venisque impressis, subtus molliter pubescentibus costa venisque prominentibus, racemis axillaribus, subcymosis, pedunculis primariis, secundariis, pedicellisque bracteolis 2 deciduis suffultis fulvescenti-pubescentibus, floribus 3–7, albis (?); sepalis aequalibus, ovatis, apice subrotundatis, 2 exterioribus utrinque, interiorum partibus expositis fulvescenti-pubescentibus, corolla calyce multo longiora, tubo brevi, ventricoso, basi intus villoso, limbo late infundibuliformi, plicato, costulis exterioribus extus dense fulvo-pilosis demum glaberrimo, in aetate utrinque 5-fisso; staminibus corollae basi insertis, filamentis glabris apice incurvis, antheris oblongis basi emarginatis, apicem versus angustatis, dorsifixis, ovario ovoideo, fulvo-pubescenti, disco annulari glabro cincto, stylis 2, brevissimis, basi vix connatis, glabris, stigmatibus globosis; capsula ovoideo-oblonga, calyce persistente glabrescente suffulta, seminibus ovoideis, plano-compressis, margine pilis fulvescentibus longissimis dense coronatis, demum parce pubescentibus.

Petiolus 1.5–2 cm. longus, laminae 7–10 cm. longae, 4–5 cm. latae. Racemi 6–6.5 cm. longi. Pedunculi primarii 2–3 cm. longi, secundarii 0.6–1 cm.; pedicelli circa 1.2 cm. longi. Sepala 6 mm. longa, 4 mm. lata. Corolla 1.3 cm. longa, tubo circa 3 mm. longo. Filamenta circiter 3 mm. longa; antherae 3 mm. longae. Ovarium plus minusve 3.5 mm. longum, stylus 2–2.5 mm. longus, stigmata 0.6 mm. diametientia. Capsula 1.6 mm. longa, semina 6 mm. longa, 5 mm. lata, pilis 1–1.2 cm. longis marginata.

PORTUGUESA: Calvario de Guanare, 200 m., on arid, bushy slopes, flowers and fruits December 28, 1925 (*Pittier* 12046, TYPE).

Breweria longepaniculata Pittier, sp. nov.

Volubilis, ramis sarmentosis subfistulosis, foliis petiolatis, coriaceis; petiolis brevibus, canaliculatis, minute adpresse pubescentibus; laminis ovalibus oblongisve, basi rotundatis, apice obtusis retusisve mucronulatis, supra glaberrimis minute reticulatis subnitidis, subtus sordide cinereo-tomentellis, nervo supra impresso subtus prominente, venis adscendentibus supra tenuiter impressis subtus utrinque prominulis; paniculis axillaribus, apice aphyllo excepto foliosis, cymis pedunculatis bis trifidis ferrugineo-pubescentibus, pedunculo petiolum subaequante vel breviori, pedicellis calyx longioribus; bracteis apiculatis brevibus, sepalis ovatis, obtusis, coriaceis, duobus exterioribus extus dense ferrugineo-pubescentibus, demum plus minusve parce pubescentibus glabrescentibusve, corolla tubuloso-campanulata, basi coarctata, extus dense fulvo-villosa, staminibus basi villoso-lanatis, antheris ovatis, cordatis, disco crasso, cupulato, ovario apice villoso, stylis duobus basi breviter connatis demum liberis filiformibus, stigmatibus capitatis subbilobulatis.

Petiolus 0.5–2.5 cm. longus; laminae 3–10 cm. longae, 2–6 cm. latae. Paniculae circa 25 cm. longae; cymarum pedunculi 0.5–1.2 cm. longi, pedi-

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[1] Received February 23, 1927.

celli 5–8 mm. longi. Sepala 6–7 mm. longa, 4–4.5 mm. lata. Corolla circa 1.8 cm. longa. Genitalia inclusa.

TRUJILLO. Moron Hill near Valera 600, m., in bushes; fl. Nov. 18, 1922. (*Pittier* 10733, TYPE).

No South American species of *Breweria* seem to have been described in recent years, and it had not been expected that the genus reached so far north I feel no hesitation, however, in placing the above described plants in this apparently not well known group, of which they represent two distinct types, the one with axillary, cymose, the other with terminal, paniculate, inflorescences. The affinities of the first species are with *Breweria Langsdorffii*, except that the flowers are not solitary and the general aspect of the plant resembles more that of *Prevostea ferruginea*. The remarkable seeds, with their dense fulvous crown of very long hairs, and the details of the flowers leave no doubt as to the generic identity of that plant; while certain structural analogies show that *B longepaniculata* is really congeneric with *B mollis*. A manuscript note on the sheet of the former plant states that "this plant seems to be the same as H. H Smith's n 876 from Santa Marta (Colombia) but it is distinct from Juan de la Cruz nn 1372 or 1358 in the U. S National Herbarium."

Aniseia trichantha Pittier, sp. nov.

Volubilis, caule subcrasso primum densissime cano-villoso, in aetate plus minusve adpresse villosulo, foliis ovatis oblongisve, basi acutis subacutisve apice late obtusis interdum subacutis utrinque mucronatis supra glabris glabrescentibusve, subtus primum creberrime sericeo-pubescentibus demum parce pilosulis, petiolo modice crasso, canaliculato, villoso; stipulis linearibus, brevibus, cito deciduis, pedunculis axillaribus, validis, tomentoso-villosis, 2–3-floribus, folia subaequantibus longioribusve, pedicellis brevibus dense villosis basi bracteis linearibus pubescentibus deciduis suffultis, apice bibracteolatis, bracteolis ovato-lanceolatis deciduis, sepalis subcoriaceis ovatis ovato-oblongisve, ciliatis, extus in partibus expositis cano-villosis, in sicco nigrescentibus, interioribus brevioribus, corolla alba infundibuliformi, in sicco nigrescenti, extus dense fulvo-pilosa; staminibus glabris, disco annulari, glabro, ovario apice dense fulvo-piloso, stylo gracili glabro, stigmatibus 2, ovalibus, muricatis Capsula (juv.) ovoidea, dense fulvo-villosa.

Petioli 0 7–1 cm longi, laminae adultae 2 5–5 cm. longae, 1–2 5 cm latae; mucro usque ad 2 mm. longus. Pedunculus 3.5–6 cm longus; pedicelli 2–7 mm. longi. Sepala 6–8 mm. longa, 5–7 mm lata. Corolla plus minusve 2 cm longa. Filamenta circa 4 mm longa Pistillum 1 5 cm. longum

COJEDES Between El Tinaco and San Carlos, in low, damp places along river, flowers and young fruits December 25, 1925 (*Pittier* 12004, TYPE)

On account of its relatively large flowers, *Aniseia trichantha* would hold an intermediary position between Meissner's *Grandiflorae* and *Parviflorae*.[3] It is distinguished from all other representatives of the genus reported from Venezuela by its villous corolla. The following is a key to the species which have been collected in the Venezuela.

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[3] Flora brasiliensis, 7: 318 1869

Corolla white, glabrous, over 2 cm. long; leaves oblong-lanceate
1. **A. martinicensis** Choisy
Corolla 2 cm. long or less.
  Corolla white, densely pilose without, 2. cm. long; leaves ovate or oblong, the base more or less acute 2. **A. trichantha** Pittier
  Corolla blue, glabrous, 1.2–1.7 cm long; leaves more or less cordate or at least broadly rounded at the base.
    Sepals glabrous, inflorescences many-flowered 3. **A. velloziana** Choisy
    Sepals tomentose; inflorescences 1–3-flowered 4. **A. heterantha** Choisy

Merremia asterotricha Pittier, sp. nov

Scandens volubilisve, caulibus, petiolis pedunculisque dense stellato-tomentosis canescentibusque, foliis distincte trifoliolatis, petiolo laminis breviore, anguste canaliculato; foliolis petiolulatis, membranaceis, petiolulis brevibus, canaliculatis, laminis ovali-oblongis, lateralibus basi inaequalibus semi-rotundatis, apice obtusis subacutisve mucronatis, supra stellato-pubescentibus, costa venisque impressis, subtus dense stellato-tomentellis cinerascentibus costa venisque prominentibus, stipulis ovatis, obtusis, deciduis, inflorescentiis axillaribus, cymosis, saepe foliosis; pedunculis primariis folia aequantibus longioribusve, plerumque ebracteatis, pedunculis secundariis tertiariisque bracteis foliaceis, petiolulatis lanceolatis suffultis, pedicellis elongatis, gracillimis; bracteolis lineari-lanceolatis, sepalis membranaceis, oblongo-ovatis, apice obtusis, mucronulatis, exterioribus 2 tomentello-cinerescentibus, interioribus gradatim angustioribus glaberrimis subpellucidis, corolla (alba?) calyce duplo longiora, genitalibus inclusis; filamentis basi pilosiusculis, pollinis granulis laevibus, trisulcatis, ovario ovoideo, dense canescenti-villoso; stylo tenuissimo staminibus duplo superante, capsula desiderata.

Petioli 4 5–5 cm longi, petioluli 2–8 mm. longi, foliolorum laminae 6–13.5 cm. longae, 2 5–5 cm. latae Stipulae 3–5 mm longae. Pedunculi primarii 9 5–11 cm., secundarii 3–5 5 cm , tertiarii 1 2–2 cm longi; pedicelli 0 6–1.7 cm. longi. Bracteae 1 5–2 cm , bracteolae 0 8–1.2 cm longae. Sepala circa 10 mm. longa, 2 5–3 5 mm. lata Corolla 2 cm longa.

LARA· Along the Turbio River near Barquisimeto; flowers June 1, 1925 (*J. Saer d' Héguert* 248, TYPE)

Merremia nervosa Pittier, sp. nov.

Volubilis, caulibus subtenuibus, striatis, cinereo-tomentellis; foliis parvis, petiolatis, trifoliolatis, petiolis sulcatis, pedunculis pedicellisque cinereo-tomentosis; petiolulis brevissimis, laminis (terminalibus majoribus) ovalibus basi in petiolulum attenuatis apice obtusis subacutisve mucronulatis, supra minute velutinis, nervo venisque impressis, subtus cinereo-velutinis, nervo venisque valde prominentibus; pedunculis axillaribus, paucifloris, bracteis linearibus brevibus deciduis suffultis, pedicellis subumbellatis, quam pedunculus multo brevioribus; bracteolis lineari-lanceolatis persistentibus; sepalis membranaceis, ovato-oblongis, apice indistincte emarginulatis vel interdum mucronulatis, 2 exterioribus stellato-furfurascentibus, interioribus glabris vel partim pubescentibus; corolla alba, glaberrima; genitalibus inclusis; filamentis basi parce villosulis; antheris oblongis, basi cordatis; pollinis granulis laevibus; ovario dense cano-villoso; stylo filiformi, glabro, staminibus subaequilongi

Petioli 0 5–1 cm. longi, petioluli subnulli; lamina terminalis 3–4 cm. longa, 1.6–2 cm. lata, laterales 2 cm. longae, 1.3–1.6 cm. latae. Pedunculi 3–4 cm.,

pedicelli circa 1 cm. longi. Bracteolae 0.7–1 cm. longae. Sepala 9–13 mm. longa, 6–7 mm. lata. Corolla 2.5 cm. longa.

LARA: Cerro Gordo near Barquisimeto, in arid places; flowers October 1926 (*J. Saer d' Héguert* 294, TYPE).

On account of their trifoliolate leaves and stellate indument, these two species constitute a natural group among the Venezuelan *Merremiae*.

KEY TO THE SPECIES OF MERREMIA KNOWN FROM VENEZUELA

- Herbs, erect or hardly voluble
  - Leaves wanting and replaced with oblong or subulate scales; corolla white — 1. **M. aturensis** Hallier
  - Leaves present, short petiolate, lineal-ovate, subcordate at the base; corolla yellowish — 2. **M. maypurensis** Hallier
- Scandent or voluble vines
  - Leaves simple, distinctly and broadly cordiform; corolla yellow, 2.5 cm. long — 3. **M. umbellata** Hallier
  - Leaves 3-foliolate; indument stellate, corolla white
    - Leaflets oval-oblong, distinctly petiololate, the blade 6–13.5 cm. long — 4. **M. asterotricha** Pittier
    - Leaflets oval, almost sessile, the blades 3–4 cm long — 5. **M. nervosa** Pittier
  - Leaves digitate, with 5 segments; corolla white
    - Sepals 6–13 mm long; plant glabrous; leaflets lanceolate, often toothed — 6. **M. quinquefolia** Hallier
    - Sepals 17–25 mm long; corolla about 4 cm. long, leaflets entire
      - Leaves appressed-pilose; sepals hirsute at the base, the exterior ones acute and longest; corolla 3 cm. long — 7. **M. aegyptia** Urban
      - Leaves glabrous; sepals glabrous, obtuse, the exterior ones shortest; corolla 4 cm. long — 8. **M. glabra** Hallier

Ipomoea pseudo-Linum Pittier sp. nov.

(Sect. *Orthipomoea*, subsect. *Lobatae.*)—Glabra, erecta, caulibus solitariis virgatis simplicibus, foliosis, foliis sessilibus usque ad basin palmatim pluripartitis, segmentis filiformibus, subteretibus, exterioribus plerumque 2–4-fidis, floribus longe spicatis, axillaribus, pedunculatis; pedunculis solitariis, quam folia brevioribus, basi bracteis 2 minimis lanceolatis suffultis, sepalis membranaceis, lanceolatis ovato-lanceolatisve, apiculatis, exterioribus extus squamoso-papillosis, brevioribus angustioribusque, corolla infundibuliformi, rosea, glabra; staminibus glaberrimis, antheris ovato-lanceolatis basi emarginatis; pollinis granulis muricato-spinulosis; disco annulari, angusto, pistillo glabro, ovario biloculari, loculis biovulatis, stylo incluso, stigmate capitato, bilobulato, papilloso, capsula parva, glabra, laevia; seminibus 4, laevibus.

Caulis 40–50 cm. altus, teres. Foliorum segmenta plus minusve fasciculata 1.5–2 cm. longa. Internodia 1–1.5 cm. longa. Pedunculi 7 mm. longi. Calyx 6 mm. longus, lobis exterioribus brevioribus. Corolla 2.5 cm. longa.

Savannas on the slopes above Caracas, 950–1300 m., in small colonies; fl. July 27, 1927 (*Pittier* 7279, TYPE); same locality, fl June 17, 1917 (*Pittier* 7218).

This pretty species, which looks like certain *Linum* species, seems to be rather scarce. It is evidently very closely related to *Ipomoea ericoides*

Meissn. described from the state of Goyaz in southern Brazil, but differs in the absence of indument, the comparatively long pedunculate flowers with short calyx and pink corolla and the distinct division of the leaves. Another species somewhat like it and probably closely related is *Ipomoea capillacea* Don, of Mexico, but in our plant the peduncles are shorter, the calyx longer, and the corolla not short, tubulous and red, but four times longer than the calyx, funnel-shaped and pink

BOTANY.—*New South American species of Liabum.*[1] S. F. BLAKE, Bureau of Plant Industry.

The strictly American genus *Liabum* is, taken in its broad sense, the largest American genus of the Senecioneae aside from *Senecio* itself. About 23 species occur in Mexico and Central America, 1 in the West Indies, and the remainder, some 89 species (including those here described), in the Andes from Venezuela to Peru, Bolivia, and Argentina. The number in the different countries is approximately as follows: Venezuela, 2; Colombia, 19, Ecuador, 32; Peru, 38; Bolivia, 13; Argentina, 4. The new species here described have been distinguished in the course of identification of the large amount of material of the genus accumulated at the United States National Herbarium in recent years, principally from the collections of Dr. F. W. Pennell and Mr. E. P. Killip in Colombia, Prof. A. S. Hitchcock and Dr. J. N. Rose in Ecuador, Mr. J. Francis Macbride in Peru, and Dr. Otto Buchtien in Bolivia. The preparation of a working key to the South American species has been greatly aided by the acquisition of photographs, fragments, and notes of typical specimens at the herbaria at Geneva, Paris, and Kew by the writer in 1925, through the courtesy of the curators of the herbaria mentioned, and through the loan by Dr. J. K. Small of several type specimens from the herbarium of the New York Botanical Garden.

Liabum arthrothrix Blake, sp. nov.

Section *Chrysactinium*, scapose, 1-headed, leaves rosulate, lanceolate or oblanceolate, small, coriaceous, callous-toothed, above bright green and densely pilose with many-celled yellowish hairs, beneath densely white-tomentose, involucre 8–11 mm high

Rhizome up to 4 cm. long, horizontal, leaves crowded in a basal rosette, without evident internodes, 1–5.5 cm. long (including the petioliform margined base, this 2.5 cm long to nearly wanting), 3–8 mm wide, acute, long-cuneate at base, callous-pointed and with 1–3 callous-pointed teeth on each side above middle, apparently not tomentose above even when young, obscurely tripli-nerved, the lateral veins concealed beneath by the tomentum, the costa usually evident, scape solitary, slender, 14–28 cm. high, naked, arachnoid-tomentose, pilose throughout with many-celled purplish hairs; head 1.8–3

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[1] Received March 21, 1927

cm. wide; involucre hemispheric, about 5-seriate, strongly graduate, appressed, the outermost phyllaries lance-triangular to ovate-triangular, obtuse to subacuminate, subcoriaceous, scarcely margined, 3-nerved, obscurely ciliolate, 0.6–1.6 mm. wide, the middle ones lance-linear, acuminate to obtuse and apiculate, 3-nerved, thinner, narrowly scarious-margined, obscurely pilose-ciliate, the innermost linear, acuminate, 1–3-nerved, thin, 0.6–1 mm. wide, all often purplish-tinged above, essentially glabrous dorsally; rays about 30, yellow, the tube 3–4.5 mm. long, pilose with many-celled hairs, the lamina linear-elliptic, 4-nerved, 3-toothed, 10–14.5 mm. long, 1.5–2.5 mm. wide; disk corollas yellow, very sparsely short-pilose toward apex of tube, clavate-glandular on teeth, 6.8 mm. long (tube 2.8 mm., throat slender-funnelform, 2.4 mm., teeth 1.6 mm. long); young achenes pilose; pappus simple, pure white, about 4.5 mm. long, the bristles finely hispidulous, not dilated apically.

ECUADOR: Páramo of Lavaguro, Prov. Loxa, Sept. 1864, *Jameson* (U. S.); Yausai, alt. 3700 m., April 1904, *Rivet* 602 (Par.), 604 (Par.), páramo, between Oña and Cuenca, Prov. Azuay, alt. 2700–3300 m., 9–10 Sept. 1923, *Hitchcock* 21645 (type no. 1,195,670, U. S. Nat. Herb.)

Distinguished from *L. acaule* (H. B. K.) Less. and *L. rosulatum* Hieron. by the articulate hairs of the upper leaf surface, and from *L. tenuior*, described below, by its smaller coriaceous leaves which show no sign of tomentum above even when young.

Liabum tenuior Blake, sp. nov.

Section *Chrysactinium*, scapose, 1-headed, leaves rosulate, lanceolate or oblanceolate, medium-sized, papery, callous-denticulate, above dull green, at first thinly arachnoid, rather densely pilose with persistent many-celled hairs, evidently 3–5-plinerved, beneath canescently and persistently arachnoid-tomentose, involucre 14 mm. high.

Rhizome short; leaves about 10 in a basal rosette, 5–7.5 cm. long (including the margined petioliform base, this 1–2 cm. long), 1–1.5 cm. wide, acute, callous-pointed, long-acuminate at base, with 2–5 remote pairs of dark callous teeth (about 0.5 mm. long), comparatively thin, reticulate-veined, the veins conspicuous in transmitted light; scape slender, naked, 43 cm. high, arachnoid-tomentose, glabrescent below, above the middle pilose with delicate, purplish, many-celled hairs, the base of involucre pilose with many-celled yellowish hairs; head about 3 cm. wide, involucre hemispheric, about 5-seriate, strongly graduate, appressed, the outermost phyllaries triangular, obtuse to acute, 3-nerved, with greenish center and narrow subscarious margins, slightly ciliate, 1.5–2 mm. wide, the middle ones narrowly oblong-lanceolate, 1.8–2 mm. wide, acute to acuminate, 3–5-nerved, the innermost linear, acuminate, 1–3-nerved, 1 mm. wide, rays apparently about 30, yellow, short-pilose with many-celled hairs toward apex of tube, the tube 5 mm. long, the lamina elliptic-linear, 4-nerved, obtusish, scarcely denticulate, 16 mm. long, 1.5 mm. wide; disk corollas yellow, pilose on tube especially toward apex, essentially glabrous on teeth, 8 mm. long (tube very slender, 4 mm. long, throat slender-cylindric, 2 mm., teeth linear, acutish, 2 mm.), young achenes pilose, 1.6 mm. long; pappus simple, pure white, 6 mm. long, the bristles slender, hispidulous, not dilated apically.

ECUADOR: Casitagua, May 1903, *Rivet* 478 (type, herb. Par., photo. and fragm., U. S.).

Closely allied to *L. arthrothrix*, but with longer involucre and much thinner leaves in which the reticulation is evident by transmitted light, while those of *L. arthrothrix* are thick and opaque. The disk corollas of the two species also differ in shape and pubescence.

Liabum bicolor Blake, sp. nov.

Section *Chrysactinium*, herbaceous (?), densely whitish-tomentose except on involucre and upper leaf surface; stems decumbent, branching, leafy below, terminated by long monocephalous peduncles; leaves oblanceolate, subentire, coriaceous, soon green and glabrate above; involucre 11 mm. high.

Leafy portion of stem about 10 cm. long or more, sometimes dichotomously branched, slender, striate, internodes 0.7–4 cm. long, leaves opposite, oblanceolate or narrowly obovate, 2–4.5 cm. long (including the petioliform margined base, this 1.5 cm. long or less), 5–9 mm. wide, obtusish, callous-apiculate, entire or with few remote callous teeth, above at first arachnoid-tomentose, quickly glabrate and dark green, not shining, beneath very densely and thickly whitish-arachnoid-tomentose, obscurely triplinerved; peduncles solitary, naked, erect, about 20 cm. high, slender, arachnoid-tomentose, pilose with delicate, many-celled, purplish hairs; head about 2 8 cm. wide; involucre hemispheric, about 5-seriate, strongly graduate, appressed, the outermost phyllaries triangular, acute, firm, 1–1.5 mm. wide, the middle ones lance-linear, 3-nerved, the innermost linear, 1–3-nerved, acuminate, 0.7–1 mm. wide, narrowly subscarious-margined, all obscurely ciliolate, with purplish tips; rays about 30 or more, yellow, the tube pilose above with several-celled hairs, 3 mm. long, the lamina elliptic-linear, 4-nerved, entire, obtuse, 12 mm. long, 1.3 mm. wide, disk corollas yellow, pilose with several-celled hairs on tube and base of throat, sparsely clavate-glandular toward tip of teeth, 7.3 mm. long (tube slender, 4 mm., throat slender-campanulate, 1 3 mm., teeth nearly linear, acutish, 2 mm.); young achenes pilose; pappus simple, pure white, 5 mm. long, the bristles hispidulous, not dilated apically.

ECUADOR: Mountains, Prov Loxa, Sept. 1864, *Jameson* (type no. 534900, U. S. Nat Herb.)

Evidently closely allied to the Peruvian *L. caulescens* Hieron. The latter is described as having oblong-cuneate subcoriaceous leaves and 1-nerved middle phyllaries.

Liabum amphothrix Blake, sp. nov.

Section *Chrysactinium*; caespitose, whitish-tomentose throughout except on involucre; stems decumbent, somewhat branched, terminating in elongate monocephalous peduncles, leafy below, leaves lanceolate to nearly linear, above pilose with several-celled hairs and persistently or fugaciously arachnoid-tomentose, beneath whitish-arachnoid-tomentose; involucre 9–12 mm. high.

Herbaceous or suffruticulose; stems several, often dichotomously branched, the leafy portion 2–20 cm. long, slender; internodes mostly 0 5–2.5 cm. long; leaves opposite, 2.5–5 5 cm. long (including the petioliform base), 3–10 mm. wide, repandly few-denticulate or sometimes subentire, acute or acuminate, callous-apiculate, papery to subcoriaceous, triplinerved, the margin sometimes revolute, the upper surface densely pilose with several-celled persistent yellowish hairs (on the upper leaves sometimes represented only by subsessile glands or even these nearly wanting), and at first arachnoid-tomentose, the tomentum often nearly or quite deciduous; peduncles solitary at tips of stems and branches, slender, naked, 13–30 cm. high, arachnoid-tomentose and especially above pilose with delicate many-celled purplish hairs; heads 3–3.5 cm. wide, decurved after flowering; involucre hemispheric, about 5-seriate, strongly graduate, appressed, the outermost phyllaries ovate or oblong-ovate, 1.5–2.8 mm. wide, obtuse, callous-apiculate, 3-nerved, very thinly arachnoid-ciliate, sometimes arachnoid-tomentose when young, the middle ones lance-oblong, acute or acuminate, callous-pointed, 3-nerved, the innermost linear or lance-linear, acuminate, 1–3-nerved, more broadly subscarious-margined, all obscurely glandular-puberulous on back above or essentially glabrous, often purplish above; rays about 30, yellow, the tube pilose with many-celled hairs, 3–4 mm. long, the lamina elliptic-linear, 4-nerved, 2–3-denticulate, 9–16 mm. long, 1.7–2.5 mm. wide; disk corollas yellow, pilose on tube above with many-celled hairs, clavate-glandular on teeth and sometimes on throat, 6.5–7 mm. long (tube slender, about 3.3 mm., throat campanulate, 1.5 mm., teeth nearly linear, acutish, with papillose apical crest, 1.8–2.3 mm.), receptacle paleaceous-fimbrillate, the fimbrillae about 1.2 mm. long; young achenes silky-pilose; mature achenes obovoid, somewhat compressed, 2.3 mm. long, 1 mm. wide, 8–9-ribbed, pilose especially above with white, brown-based hairs, densely verrucose especially on ribs below; pappus nearly simple, about 2-seriate, pure white, somewhat unequal, 5 mm. long, the bristles hispidulous, not thickened above.

PERU: In deep grass of slopes, Mito, Dept. Huánuco, alt. 2745 m., 8–22 July 1922, *Macbride & Featherstone* 1665 (type no. 518161, herb. Field Mus.; dupl. in U. S. Nat. Herb.), sunny grassy swale, Chinchapalca, about 13 km. above Mito, alt. 2900 m., 16–27 July 1922, *Macbride & Featherstone* 1591 (Field, U. S.); among rocks, about 24 km. northeast of Huánuco, alt. 3965 m., 12–22 June 1922, *Macbride & Featherstone* 2157 (Field, U. S.).

Allied to *L. caulescens* Hieron. and *L. bicolor* Blake, but distinguished by the persistent jointed pubescence of the upper leaf surface, which is sometimes lacking on the uppermost leaves. No. 1591 is a form with leaves only about 3 mm. wide.

Liabum perfoliatum Blake, sp. nov.

Section *Starkea* (?), stem, peduncles, and lower leaf surface tomentose; leaves elliptic or ovate-elliptic, crenate, green and bullate above, connate-perfoliate; heads small, in umbels of about 3 at apex of elongate peduncles, slender-pedicelled; involucre 6–7 mm. high, strongly graduate, the phyllaries oval to linear-elliptic, obtuse, appressed.

Perennial herb, 60 cm. high; stem essentially simple, subterete, sometimes weakly grooved, densely grayish-tomentose, bearing about 10 pairs of leaves and 1–3 terminal peduncles; leaves 4.5–11 cm. long, 1.8–4 cm. wide, acuminate to a usually obtuse apex, cuneately and gradually or sometimes abruptly narrowed to the connate bases (these 2–7 mm. wide), crenate-dentate (teeth low, rounded, crenulate, 5–7 mm. apart), thin-papery, above deep green, quickly glabrous, strongly and beautifully bullate, beneath densely whitish- or grayish-tomentose, featherveined, the lateral veins about 8–10 pairs, not prominent; peduncles slender, 10–16 cm. long, rather thinly tomentose and finely pilose chiefly above with jointed purplish hairs, bracts minute, 2 mm. long; pedicels erect, 1–5.5 cm. long, naked, normally monocephalous; heads 2 cm. wide, disk 7 mm. high; involucre campanulate, 5–6-seriate, thinly arachnoid, glabrescent or glabrate, the outermost phyllaries ovate or oval, about 1 mm. long, rounded, the next ovate to oval, rounded, with greenish 3-nerved center and narrow substramineous margin, about 1.5 mm. wide, the inner linear-elliptic or linear, obtusish or acutish, substramineous with greenish midnerve; receptacle alveolate, the alveolar margins subentire, about 0 2 mm. high; rays about 15, yellow, the tube and base of back pilose, the lamina oblong, about 10 mm. long, 2 mm. wide, disk corollas (immature) comparatively few, yellow, sparsely pilose on tube, hispidulous at apex of teeth; young achenes about 7-ribbed, sparsely pubescent, 0.7 mm. long; pappus yellowish white, of about 12 unequal, flattened, fragile, hispidulous bristles 1 5–2.5 mm long, and perhaps also a few short squamellae.

COLOMBIA: In forest, "La Gallera," Micay Valley, Dept. El Cauca, Cordillera Occidental, alt 2000–2200 m., 1 July 1922, *Killip* 7952 (type no. 1,140,317, U. S. Nat. Herb.).

A most distinct species of the *L. grandiflorum* group, readily recognized by its leaves, inflorescence, and involucre The disk corollas, achenes, and pappus are too immature to be described satisfactorily.

Liabum amplexans Blake, sp nov.

Section *Starkea*; herb; stem, lower leaf surface, peduncle, and pedicels tomentose, leaves broadly ovate, rough above, triplinerved, abruptly narrowed into short, broadly winged, connate-clasping petioles, peduncle solitary, terminal, elongate, the heads medium-sized, about 10 in a subsimple umbellate cyme, involucre 9–11 mm. high, the phyllaries lance-subulate, acuminate.

Stem apparently decumbent at base, obtusely about 6-angled, 3 mm. thick, below thinly arachnoid-tomentose and densely pilose with jointed purplish hairs, above obscurely jointed-pilose, lower internodes 1.5–5 cm. long, the uppermost one 15 cm ; leaves in few pairs, the larger broadly cordate-ovate, the blades 4.5–7 5 cm long, 3.5–5.5 cm wide, abruptly contracted into broadly winged connate-clasping petioles 7–15 mm. long and 4–10 mm. wide, acute, closely serrate with callous-mucronate teeth (the mucros slender, 1 mm. long), firm papery, above dull deep green, subbullate, densely-hispidulous with jointed yellowish hairs, and with a slight fugacious arachnoid tomentum, beneath densely whitish-tomentose, along veins densely pilose with jointed yellowish brown hairs, triplinerved from base of blade and reticulate, the veins and veinlets prominulous beneath; uppermost pair of leaves smaller, 3 cm. long, peduncle 18 cm long; principal bracts narrow, bladeless, 1 cm. long, pedicels mostly 2.5–4.5 cm. long, involucre hemispheric, about 6-seriate, strongly graduate, the phyllaries triangular-subulate to linear, acuminate or attenuate, 1-nerved, 1–1 4 mm. wide, erect, thinly arachnoid, glabrate or glabrescent, ciliolate, the inner puberulous above, the outer purplish, the inner substramineous; receptacle alveolate, the alveolar margins toothed, about 0 3 mm. high; rays about 32, yellow, pilose on tube and base of back, the tube 3.5 mm long, the lamina linear, 4-nerved, bidenticulate, 6.5 mm. long, 1 mm. wide, disk corollas numerous, yellow, glabrous except for the apically hispidulous teeth, 6 7 mm long (tube 3 4 mm., throat campanulate, 1.3 mm., teeth apically thickened, 2 mm); immature achenes 10-ribbed, pilose, 1.2 mm. long, pappus yellowish white, the inner bristles hispidulous, obscurely or not dilated apically, 5 mm. long, the outer few, setiform, 0.5–1 mm. long

ECUADOR: Vicinity of Las Juntas, 29 Sept. 1918, *Rose, Pachano, & Rose* 23232 (type no 1,023,386, U. S. Nat. Herb.).

Allied to *L. grandiflorum* (H. B. K.) Less., in which the leaves are smooth to the touch above and the involucre 13 mm. high, and to *L. weberbaueri* Muschl., which is described as having the leaves arachnoid-tomentose and glabrate above, the involucre shorter and phyllaries broader, and the rays longer. *Hitchcock* 21452, from between Loja and San Lucas, may be a poorly developed form of *L. amplexans*.

Liabum subcirrhosum Blake, sp. nov.

Section *Andromachia;* plant densely whitish-arachnoid-tomentose except on upper leaf surface and involucre; leaves triangular-ovate, greenish above, borne on slender, very narrowly margined, connate-auriculate petioles, heads medium-sized, in small rather close cymes, involucre 11–12 mm. high, the phyllaries all subulate, densely glandular-pilose above, attenuate, the inner subcirrhous-tipped.

Apparently herbaceous, "80 cm. high," stem terete, 4 mm. thick, hollow, branched above; internodes mostly 4–8 cm. long, leaves opposite, the upper alternate, petioles 2.5–3 cm. long, abruptly dilated at base into connate mucronate-denticulate auricles 4–7 mm. high, blades 6–7.5 cm. long, 3.5–4 cm. wide, acuminate, at base narrowly or broadly cuneate, mucronulate along margin (mucros slender, callous-tipped, 0.5 mm. high, 3–10 mm. apart) and obscurely repand, thin-papery, above thinly arachnoid and puberulent, glabrescent, beneath densely white-arachnoid-tomentose, subtriplinerved (the veins about 6 pairs, the lowest pair somewhat stronger than the others), heads about 2.5 cm. wide, in irregular cymose clusters of 3–8 at apex of stem and branches, the densely tomentose pedicels mostly 2–4 cm. long; involucre about 5-seriate, strongly graduate, arachnoid-tomentose at base, densely glandular-pilose with yellowish white (or in the outer phyllaries purplish) hairs above, the phyllaries all 1 mm. wide or less, subulate to narrowly linear-subulate, with loose attenuate tips (in the innermost subcirrhous), the outer purplish, the inner greenish stramineous, the middle ones 3-nerved, receptacle merely foveolate; rays about 50, yellow, pilose on tube and base of back, the tube 3 mm. long, the lamina linear, 4-nerved, 3-denticulate, 9 mm. long, 1.2 mm. wide, disk corollas numerous, yellow, slenderly cylindric-funnelform, sparsely pilose on tube and throat, pilose-tufted at apex of teeth, 6.4 mm. long (tube 2.2 mm., throat scarcely distinguished, 1.8 mm., teeth 2.4 mm.); achenes densely hispidulous, 1.8 mm. long, pappus double, brownish white, the inner of 20 or more fragile, strongly hispidulous, not apically dilated bristles 6 mm. long, the outer of about as many persistent blunt lacerate squamellae about 0.3 mm. long.

ARGENTINA: Rare, La Playa, Dept. Andalgalá, Prov. Catamarca, 12.2. 1917, *P. Jörgensen* 1673 (type no. 922182, U. S. Nat. Herb.).

Allied to *L. candidum* and *L. auriculatum* Griseb., especially the former, from which it is distinguished by its considerably narrower phyllaries with extremely attenuate tips. The three may eventually require a separate section for their reception.

Liabum excelsum (Poepp.) Blake.

Andromachia excelsa Poepp. Nov. Gen. & Sp. 3: 44. 1845.

This species has not been recognized among the material examined, but from description seems to be distinct. It is customary to cite the new plants described in all three volumes of the "Nova Genera ac Species" as of Poeppig & Endlicher. The title pages of the first two volumes bear the names of both botanists, but that of volume 3 the name of Poeppig only, so that it seems necessary to attribute to Poeppig alone the authorship of the new genera and species in this volume.

Liabum mikanioides Blake, sp. nov.

Section *Oligactis;* scandent shrub, stem and branches densely short-pilose with jointed brownish hairs and obsoletely arachnoid-tomentose; leaves ovate or oval-ovate, serrulate, coriaceous, glabrous above, densely tomentose beneath, short-petioled, heads small, 10-flowered, subsessile, very numerous and subspicate on the wide-spreading branches of axillary and terminal pyramidal panicles.

Stem subterete, striate, solid, brown-pithed, 3–5 mm. thick, leaves opposite; petioles very stout, 8–10 mm. long, naked, not auriculate, above flattish and persistently sordid-tomentose, beneath rounded and glabrate; blades 6–11 cm. long, 3.5–6.5 cm. wide, acute or obtusish, broadly cuneate-rounded at base, callous-serrulate except toward base (teeth acutish, 0.5 mm. high, 2–8 mm. apart), above deep dull green, quickly glabrate and smooth except usually along costa, beneath densely tomentose with brownish-white hairs, featherveined, the chief lateral veins 8–10 pairs, prominulous above, prominulous and glabrescent beneath, panicles about 15 cm long, 8 cm. wide, the branches densely floriferous except at base, spreading at a right angle, the lower ones subtended by reduced leaves, the heads spicately clustered on short branchlets, involucre 5–6-seriate, strongly graduate, 3.5 mm. high, the phyllaries ovate (outer) to linear-elliptic, 1 mm. wide or less, obtuse, firm, brownish, somewhat darkened toward apex, essentially nerveless, somewhat deciduously arachnoid-pilose-ciliate and ciliolate, receptacle alveolate, corollas not seen; achenes about 10-ribbed, pilose, 2 mm. long; pappus yellowish white, double, the inner of about 30 hispidulous, apically dilated, somewhat flattened bristles 4.5 mm. long, the outer of about 20 narrowly linear acute or acuminate squamellae 1.2–1.5 mm long.

COLOMBIA: "Climbing shrub, flowers yellow," in clearing, "Alaska," above Salento, Cordillera Central, Dept. Caldas, alt. 3000–3400 m., 10–13 Aug. 1922, *Pennell* 9706 (type no. 1,141,228, U. S. Nat. Herb.).

Closely allied to *L. sessiliflorum* (H. B. K.) Less. In that species the branches are persistently arachnoid-tomentose, without jointed hairs, and the leaves are elliptic to elliptic-oblong, acuminate, one-quarter to one-half as wide as long. The species is named in reference to its close habital resemblance to such species of *Mikania* as *M. houstoniana* (L.) Robinson.

Liabum subviride Blake, sp. nov.

Section *Munnozia*; stem 6-angled, arachnoid, soon glabrate, leaves triangular-hastate, soon glabrous and green on both sides, the petioles narrowly winged above, connate-auriculate at base; heads small, yellow, very numerous in a terminal flattish panicle.

"Shrub," stem (above) weak, hollow, about 5 mm. thick, rather obtusely 6-angled, striate, reddish-brown, sparsely arachnoid, soon nearly completely glabrate; leaves opposite; petioles cuneately margined above (or in the uppermost leaves nearly to base), 2–4.5 cm. long, 4–7 mm. wide above, connate-auriculate at base, the appendages reniform, about 3 mm. high; blades 10–11 cm. long, 7.5–9.5 cm. wide across the wide-spreading, narrow, acuminate basal lobes, 3.5–5.5 cm. wide just above them, acuminate or attenuate, at base subtruncate and then shortly cuneate-decurrent on petiole, repand-dentate or serrate (teeth 1–3 mm. high, 3–8 mm. apart), above deep green, thinly arachnoid, glabrate or glabrescent, beneath somewhat lighter green, thinly arachnoid, quickly glabrate except sometimes along costa, subpapyraceous, triplinerved from near base, the veins delicate, barely prominulous beneath, panicle ternately divided, about 18 cm. long and wide, very many-headed, flattish, pilosulous with several-celled brownish hairs, the pedicels very slender, mostly 2–2.5 cm. long, the lowest bracts of inflorescence similar to the leaves but smaller, the others mostly tiny, subulate-linear; heads about 42-flowered, about 1.5 cm. wide; disk in fruit 7–8 mm. high; involucre campanulate-hemispheric, about 4-seriate, strongly graduate, 4–6 mm high, the phyllaries lance-ovate or oblong-ovate (outer 1.3–1.5 mm. wide) to narrowly oblong, acute, the outer thinly pilose-ciliate, 3–5-nerved, and with short subherbaceous tips, the inner substramineous, essentially glabrous, 3-nerved, rays about 20 (?), 1-seriate, the tube pilose, 2.2 mm long, the lamina elliptic, 2-3-denticulate, 6.5 mm. long, 1.8 mm. wide, glandular-puberulent dorsally; disk flowers about 24 (?), the corollas 5.5 mm long (tube slender, pilose with jointed hairs above, 3 mm long, throat campanulate, 0 8 mm. long, teeth 1.7 mm. long, slightly yellowish-crested at tip, clavate-glandular on back above), receptacle deeply alveolate, the alveolar margins lacerate-ciliate, about equaling the ovaries; achenes subterete, about 10-ribbed, hirsutulous above, 1 2 mm. long; pappus brownish-white, the inner bristles numerous, slender, not thickened apically, hispidulous, 5 mm. long, the outer few, similar, half or two-thirds as long.

PERU: "Shrub with yellow flowers," Lucumayo Valley, not far from Ollantaytambo, Prov. Cuzco, alt 1800–3600 m., 19 June 1915, *O. F Cook & G. B. Gilbert* 1365 (type no. 604546, U. S. Nat Herb)

Related to *Liabum hastifolium* Poepp. In a long series of that species from Columbia, Ecuador, Peru, and Bolivia, the leaves are always densely pilose with jointed hairs above and persistently white- or gray-tomentose beneath, the petioles are never auricled, and the panicle is nearly always strongly convex.

Liabum angustum Blake, sp. nov.

Section *Munnozia*; branches 6-angled, densely pilose with dark many-celled hairs below, above thinly arachnoid and less densely pilose; leaves narrowly lance-hastate, glabrous above, white-tomentose beneath, the slender naked petioles connate-auriculate; heads rather small, in loose cymose panicles on axillary and terminal branches, involucre 5-6 mm. high, essentially glabrous.

"Liana;" branches pithy, 3-4 mm. thick, 6-angled and striate; leaves opposite; petioles slender, channeled, 2–2.5 cm. long, sparsely pilose and arachnoid, essentially naked except at base where abruptly widened into connate auricles, the appendages reniform or semiorbicular, subentire, up to 8 mm. long; blades narrow-lanceolate or linear-lanceolate, 8–11 cm. long, 0.8–2.4 cm. wide across the short narrow acuminate (sometimes obsolete) basal lobes, about the same breadth near middle, long-acuminate and somewhat falcate, very shortly cuneate at base, remotely callous-denticulate, coriaceous, above deep green, glabrous, beneath densely and closely whitish-tomentose (the costa and chief veins glabrate), weakly triplinerved; heads (immature) about

1.8 cm. wide, in 4–7-headed narrow cymose panicles on axillary and terminal peduncles, these densely puberulent with short dark many-celled hairs and obscurely arachnoid, the bracts small, linear, the pedicels flexuous, divaricate, mostly 2–3 cm. long; involucre about 4-seriate, slightly graduate, the outermost phyllaries few, lance-oblong, acute, ciliate, the next ovate or oval-ovate, 5–7-nerved, about 1.5 mm. wide, substramineous, with short subherbaceous subglandular acute tip, the innermost linear-lanceolate, acuminate, glabrous, about 3-nerved; receptacle deeply alveolate, the alveolar margins lacerate, membranous, about 3 mm. long, rays (very immature) about 35, the tube and base of limb pilose, the tube about 1 mm. long, the lamina 4-nerved, linear, bidenticulate, about 6 mm. long; disk corollas (very immature) about 66, pilose on tube, clavate-glandular toward tip of teeth, 4 mm. long (teeth 1.5 mm); immature achenes hispidulous, pappus (immature) brownish, about 4 mm. long, setose, not obviously biseriate.

PERU: "Liana, flowers light yellow," Villcabamba, an hacienda on Río Chinchao, Prov. Huánuco, alt. 1830 m., 17–26 July 1923, *Macbride* 5198 (type no. 536236, Field Mus.; dupl. no 1,191,539, U. S. Nat. Herb.).

Allied to *L. lanceolatum* (Ruiz & Pav.) Sch. Bip., to which *Cook & Gilbert* 1361 and 1370, from the Lucumayo Valley of Peru, are somewhat doubtfully referred. In that plant the leaves are hastate-sagittate and strongly cordate at base, there are no "stipular" appendages, and the stem lacks the long dark hairs of *L. angustum*. The Peruvian *L. trinerve* (Ruiz & Pav.) Sch. Bip. and *L. venosissimum* (Ruiz & Pav.) Sch. Bip. are also allied, but both are so briefly described that they cannot be identified without examining authentic specimens.

LIABUM SAGITTATUM Sch. Bip. Flora **36**: 37. 1853.

Munnozia sagittata Wedd. Chlor. And. **1**: 211. 1857.
Chrysastrum sagittatum Willd.; Wedd. Chlor. And. **1**: 211. 1857, as synonym.
Liabum hastatum Britton, Bull. Torrey Club **19**: 263. 1892.
Munnozia hastata Wedd., Britton, Bull. Torrey Club **19**: 263. 1892, as synonym.

This common species, ranging from Colombia to Peru and better represented in herbaria than most members of the genus, is variable in involucral characters and may be capable of subdivision. Owing to uncertainty as to the identity of *L. trinerve* (Ruiz & Pav.) Sch. Bip. and *L. venosissimum* (Ruiz & Pav.) Sch. Bip., which are evidently very closely related, it seems best at present not to attempt segregation. Schultz's species was based on a Humboldt plant in the herbarium of Willdenow, said to be from Peru, and on *Linden* 805 and *Funck & Schlim* 1293 from Colombia. Weddell's name, independently proposed but likewise derived from Willdenow's herbarium name, was based on *Jameson* 392 from Ecuador and three collections from Colombia (*Humboldt & Bonpland*, *Goudot*, and *Funck & Schlim* 1293). The sheet of *Jameson* 392 in the Kew Herbarium bears the false name *Munnozia hastata* Wedd., on which Britton based the name *Liabum hastatum*, although citing the page of the "Chloris Andina" on which the name *M. sagittata* appears. Willdenow's generic name, *Chrysastrum*, was published (as a subgenus) by Schultz in the form *Chrysartrum*, evidently by error

Liabum eriocalyx Blake, sp. nov.

Section *Munnozia*; suffrutescent; stem subterete, densely arachnoid-tomentose, glabrate below; leaf blades narrowly oblong, about 4 times as long as wide, slightly hastate or sagittate, subpenninerved, above densely pubescent with short several-celled hairs and somewhat arachnoid, beneath densely and sordidly arachnoid-tomentose, the stout petioles wingless, exauriculate; heads few, cymose, medium-sized; involucre 7–8 mm. high, scarcely graduate, densely and persistently arachnoid-tomentose.

"Half-woody liana;" stem stout, 5–8 mm thick, striate-ridged, the tomentum brownish-white, internodes on young branches 1–4 cm. long, on the old stem elongate; leaves opposite; petioles 1.5–3 cm long, sometimes barely winged above, channeled, densely arachnoid-tomentose and beneath the wool sordid-pubescent with jointed hairs; blades 9–12.5 cm long, 2–3 cm. wide, acuminate, callous-pointed, at base short-cuneate to subtruncate or slightly cordate (the ears short, about 3 mm. long), callous-denticulate (teeth 0.5 mm. high, 4–8 mm. apart), coriaceous and apparently fleshy, heads 2.5–3 cm. wide, 5–9 in a terminal cyme or cymose panicle (the lower branches subtended by leaves), the pedicels tomentose, mostly 5–10 cm. long; involucre broad, about 4-seriate, the outer phyllaries ovate or oval-oblong, obtuse, about 3 mm. wide, the innermost lance-oblong to linear-lanceolate, acute or acuminate, 3–5-nerved, glabrate, receptacle deeply alveolate, the alveolar margins submembranous, ciliate, about 3 mm long; rays about 28, yellow, pilose on tube and base on back, the lamina linear, 4 (rarely 6) -nerved, 15 mm. long, 1.5 mm. wide, disk corollas numerous, yellow, pilose on tube, 9.2 mm. long (tube 5 mm. long, throat 2 2 mm , teeth 2 mm., apically thickened); young achenes turbinate, about 10-ribbed, hispidulous, 1 3 mm. long; pappus brownish white, of slender hispidulous graduate setae, not thickened apically, the inner 6 mm. long, the outer about 3 mm long.

PERU: "Semi-woody liana in partially sunny thicket," Hacienda Schunke, La Merced, Dept. Junin, alt 1220 m , 27 Aug –1 Sept. 1923, *Macbride* 5783 (type no 536813, Field Mus , dupl no. 1,191,551, U S. Nat. Herb).

Nearest *L corymbosum* (Ruiz & Pav.) Sch. Bip , which has a thinly arachnoid or glabrate involucre and shorter, proportionately much broader leaves (the blades 5 5–10 cm. long, 3–5 cm. wide).

LIABUM CORYMBOSUM (Ruiz & Pav.) Sch. Bip. Flora 37: 34. 1853. *Munnozia corymbosa* Ruiz & Pavon, Syst. Veg. Peruv Chil 195 1798.

This species, very briefly described by its authors, is represented at the Paris Herbarium by a sheet from the herbarium of Pavon, received from Boissier and labeled *Munnozia corymbosa*, Fl Peru. Agreeing well with the short diagnosis, it may be accepted as authentic for the species. Fragments of this plant obtained for the National Herbarium through the courtesy of Dr. H. Lecomte agree excellently with Macbride's no 3886 from Huacachi, near Muña, Peru, alt. 1980 meters, described as a liana with fleshy upper parts and bright yellow flowers The species is distinguished, among the Munnozias of the *L. sagittatum* group, by its fleshy, densely rufescent-lanate-tomentose young branches and its triangular-ovate, merely cordate or slightly sagittate leaves (5.5–10 cm. long, 3–5 cm. wide) above densely pubescent with jointed hairs and at first arachnoid-tomentose, beneath grayish-tomentose. The heads are about 10 to 13, long-peduncled at tips of branches in loose cymose panicles, and the involucre is 7–8 mm. high; the petioles are not auriculate.

Liabum isodontum Blake, sp. nov.

Section *Munnozia*; stem, petioles and inflorescence thinly arachnoid-tomentose and densely pilose with jointed purplish hairs; leaves oblong-triangular, sagittate-hastate, weakly triplinerved and veiny, rather evenly dentate, pilose above, grayish-tomentose beneath, petioles naked, not auriculate; heads numerous, medium-sized, cymose-panicled, long-pedicelled; outer phyllaries ovate or ovate-lanceolate, 2 mm. wide or more.

Suffrutescent (?), stem stout (5 mm. thick), subterete, striate; leaves opposite; petioles slender, 3.5–5 cm. long, 1–2 mm. wide, channelled above; blades 11–13.5 cm. long, 4–5.5 cm. wide, acuminate, sagittate-hastate with broadly triangular sinus and short, acuminate lobes, rather evenly crenate-dentate (teeth about 2 mm. high, 3–6 mm. apart, acute but usually appearing obtuse by the reflexing of the tips), firm-papery, above deep green, rather densely pilose with weak, jointed, brownish hairs, beneath similarly pilose along the veins and thinly gray-tomentose, heads about 3–3.5 cm. wide, about 40 in a loose panicle made up of axillary and terminal branches, the upper bracts small, linear-subulate, the pedicels usually 2–5 cm. long; involucre about 4-seriate, somewhat graduate, 7–8 mm high, short-pilose with jointed purplish hairs, the outermost phyllaries ovate, acute or subacuminate, purplish above, usually 2–2 8 mm. wide, the others lance-ovate to (inner) lanceolate, acuminate, 3–7-nerved, the lax tips purplish or in the innermost greenish; receptacle deeply alveolate, the alveolar margins lacerate-ciliate, about 3 mm long, rays 20 or more, yellow, pilose on tube and back, the tube 3 mm. long, the lamina linear, 4-nerved, bidenticulate, 2.3 cm. long, 1.5 mm. wide; disk corollas numerous, yellow, 8 mm. long (tube 3 mm., pilose with jointed hairs of biseriate cells, throat slender, 2 2 mm , teeth 2.8 mm., clavate-glandular on back and sparsely pilose-barbate near apex), young achenes turbinate, densely hirsute-pilose; pappus brownish white, of slender weakly hispidulous graduate setae, not dilated at apex, the inner 6 mm. long, the outermost 1 mm. long.

BOLIVIA: Unduavi, North Yungas, alt. 3300 m., Nov. 1910, *Buchtien* 4808 (type no. 1,179,268, U. S. Nat Herb.).

Nearest *L. glandulosum* Kuntze, also a Bolivian species, known only by the type in the herbarium of the New York Botanical Garden. In that plant the leaves (only the uppermost known) are broadly triangular (8 by 5 cm.), coarsely doubly dentate with acute teeth and with long, slender, acuminate, wide-spreading basal lobes; the petioles are broad and submarginate; and the phyllaries are all narrowly lanceolate or oblong-lanceolate and less than 2 mm. wide.

Liabum taeniotrichum Blake, sp. nov.

Section *Munnozia*, stem densely and sordidly spreading-pilose with many-celled dark hairs and sparsely arachnoid; leaves petioled, oblong-ovate, shallowly cordate at base, repand-dentate, above green and evenly pilose on surface with many-celled dark hairs, beneath similarly but more densely pilose and with a very sparse arachnoid tomentum; heads several, rather large, long-peduncled, with numerous long rays; involucre about 8 mm. high, the phyllaries slightly graduate, ovate to lanceolate, acuminate, loose, ciliolate and pilose; achenes densely pilose.

Stem herbaceous above, striate, 4 mm. thick; leaves opposite; petioles naked, not auriculate at base, pubescent like the stem, 2.5 cm. long; blades 13.5 cm. long, 6 cm. wide, acuminate, callous-tipped, rather coarsely repand-dentate throughout except toward apex (teeth acute, callous-tipped, about 2 mm. high, 4–8 mm. apart), more densely pilose along the veins on both sides, papery, obscurely triplinerved, weakly prominulous-reticulate on both sides, the basal pair of nerves arising near the base, strongly curved, extending about one-third length of leaf, the other chief lateral veins 6–7 pairs, spreading nearly at a right angle, all uniting near margin of blade, uppermost leaves much smaller, oblong-ovate, cuneate at base; heads 4.5 cm. wide, yellow, the peduncles 11–17 cm. long, axillary and terminal, 3–4-headed, the bracts subulate, about 1 cm. long, the pedicels 3–8 cm long, pubescent like the stem; involucre about 3-seriate, scarcely graduate, the outermost phyllaries ovate or lance-ovate, with pale subchartaceous body and short loose or spreading acuminate herbaceous tip, the inner lanceolate, with loose acuminate subherbaceous tips, all rather sparsely or densely pilose on surface with purplish or whitish, jointed, sometimes gland-tipped hairs, densely ciliolate with whitish hairs, and at first somewhat arachnoid; receptacle deeply alveolate, the alveolar margins lacerate-ciliate, about 3 mm. long, rays about 40, hirsute on tube and back (the hairs composed of 2-seriate cells, not notched at apex), the tube 2 mm. long, the lamina linear, 4-nerved, 3-denticulate, 17 mm. long, 2 mm. wide; disk corollas very numerous, densely spreading-hirsute on tube, base of throat, and teeth, sparsely so on throat (the hairs of 2-seriate cells), 6.5 mm long (tube 2.3 mm., throat oblong, 1.7 mm., teeth 2.5 mm.); achenes (very immature) turbinate, densely appressed-pilose, 1 mm. long; pappus of numerous yellowish-white hispidulous bristles 6 mm. long and some shorter equally slender outer ones 1.5–2 5 mm. long.

PERU. Province of Chachapoyas, *Mathews* (type in Kew Herb ; photog. and fragm., U. S. Nat. Herb).

Evidently close to *L. isodontum*, described above, but without the sagittate leaf-bases of that species.

Liabum pulchrum Blake, sp nov.

Section *Munnozia;* stem, petioles, and inflorescence thinly arachnoid-tomentose and densely pilose with dark jointed hairs; leaf blades triangular-hastate, lobulate-decurrent on upper part of petiole, persistently jointed-pilose above, the petioles with large, dentate, connate auricles; heads large, in a loose cymose panicle, long-pedicelled; involucre 1 2–1 5 cm high

"Liana;" stem stout, weak, hollow, bluntly striate-angled, 5–8 mm. thick, the tomentum deciduous below; leaves opposite, petioles 5–7 cm. long, rather slender, lobulate-winged for 1–1 5 cm at apex (lobes about 4 pairs, unequal, acute, 3–9 mm long), then naked, at base abruptly dilated into connate lobate-dentate auricles about 1 cm high, blades 10–12 cm long, 7–11 cm. wide across the basal lobes, 5–9 cm. wide just above them, acuminate, shallowly cordate at base with wide-spreading acuminate basal lobes, rather evenly repand-dentate (teeth deltoid, mucronulate, 1–2 mm. high, 2–5 mm. apart), firm-papery, above deep green, beneath densely jointed-pilose with purplish hairs on veins and veinlets and sparsely so on surface, and thinly gray-arachnoid-tomentose (the tomentum obsolescent in age), strongly triplinerved from base;

heads 7 cm. wide, about 6–20 in loose terminal and axillary cymose panicles, the bracts small, the rather stout flexuous pedicels 4–9 cm. long; involucre broad, about 4-seriate, slightly graduate, jointed-pilose, the 2 or 3 outer series of phyllaries oblong-ovate or lance-oblong, acuminate, 2.8–4 mm. wide, substramineous, often purplish-margined and -tipped, weakly many-nerved, the innermost lance-linear, long-acuminate, 3–5-nerved, with rather loose obscurely greenish tips; receptacle deeply alveolate, the alveolar margins lacerate-ciliate, 3 mm long; rays about 40, yellow, pilose on tube and back, the tube 4 mm. long, the lamina linear, 5-nerved, 3.2 cm. long, 2 2 mm. wide, disk corollas numerous, yellow, pilose on tube and sparsely on teeth, at apex of teeth pilose-barbate, 10 mm. long (tube 5 mm., throat 2 mm., teeth 3 mm.); immature achenes oblong, about 10-ribbed, sparsely hirsute, 1.6 mm. long; pappus brownish, of slender finely hispidulous graduate setae, not dilated at apex, the innermost bristles 9 mm long, the outermost 2.5 mm

PERU "Beautiful liana, bright yellow," Muña, trail to Tambo de Vaca, Dept Huánuco, alt 2110 m., 5–7 June 1923, *Macbride* 4312 (type no. 535394, Field Mus., dupl. no 1,191,493, U. S. Nat. Herb.).

Related to the Bolivian *L pinnulosum* and *L. hirtum* Kuntze, but readily distinguished by its much larger involucre, in addition to other characters.

LIABUM RUSBYI Britton, Bull. Torrey Club 19: 263. 1892.

In the original description the color of the flowers was not mentioned. In *Buchtien* 3032, described as a shrub 2 *m.* high, the "flowers" (probably the rays) are said to be violet, a color hitherto unrecorded in the genus

Liabum hexagonum Blake, sp. nov.

Section *Munnozia;* "scandent shrub," stem thinly arachnoid, strongly 6-angled, leaves elliptic or lance-elliptic, subentire, thin-coriaceous, glabrous and immersed-veined above, densely ochroleucous-tomentose with obscure venation beneath, the short barely margined petioles connate-auriculate at base; heads few, loosely cymose-panicled, long-pedicelled, outer phyllaries with spreading blunt tips

Stem stout (6 mm. thick), hollow but firm, the angles ridged, the thin tomentum deciduous except from the deep grooves; main internodes 7–12 cm. long; leaves opposite, petioles scarcely margined, channelled, thinly arachnoid, abruptly widened at base into reniform or suborbicular entire connate auricles 4–7 mm. long, blades 9 5–15 cm. long, 2–3 8 cm. wide, acuminate, somewhat falcate, acutely cuneate at base, finely serrulate (teeth minute, subremote, mostly concealed by the slightly revolute margin), above deep green, reticulate-veined (the veins immersed), penninerved, the chief lateral veins about 12–15 pairs; heads about 2 8 cm. wide, about 9 in a terminal loose cymose panicle, the bracts small or minute, the pedicels 5–11 cm long, thinly arachnoid and densely jointed-pilosulous, involucre hemispheric, about 4-seriate, graduate, 7–9 mm. high, the 2–3 outer series of phyllaries ovate-oblong or oval, about 3 mm. wide, with pale base and spreading rounded submembranous tips, thinly arachnoid outside, glabrous inside, the inner oblong, obtuse, the innermost lance-oblong, acuminate, thinly arachnoid and somewhat jointed-pilosulous; receptacle alveolate, the alveolar margins prolonged into triangular teeth 1 mm. long; rays 18 or more, yellow, the tube pilose, 4 5 mm. long, the lamina oblong, 4-nerved, 9 mm long, 3.5 mm. wide; disk corollas yellow, 7.5 mm. long (tube pilosulous, 3.5–4 mm. long, throat campanulate, 0 8–1 mm. long, teeth 3 mm. long, clavate-glandular on back and barbate-pilosulous at tip); young achenes about 10-ribbed, sparsely pilose; pappus brownish, graduate, of obscurely hispidulous bristles, not dilated apically, the inner 5 mm. long, the outermost 1 mm.

BOLIVIA: Unduavi, North Yungas, alt. 3300 m., Nov. 1910, *Buchtien* 3079 (type no. 43733, U. S. Nat. Herb.).

Nearest *Liabum rusbyi* Britton, and, like it, probably to be included in the section *Munnozia*. The strongly 6-angled stem, subentire leaves, and blunt spreading phyllaries characterize the species.

Liabum silphioides (Poepp.) Blake.

Prionolepis silphioides Poepp. Nov. Gen. & Sp. **3**: 55. *pl.* ***261***. 1845.

Liabum affine Blake, sp. nov.

Section *Munnozia*; stem subterete, arachnoid-tomentose, glabrescent or glabrate; leaves large, oblong-ovate, crenate-dentate, soon glabrous above, densely tomentose beneath, feather-veined, subcoriaceous; heads few, large, short-rayed, on long pedicels, involucre 1.2 cm. high, of oval or oblong, broadly rounded, submembranous-tipped phyllaries; pappus as long as tube of disk corollas, flowers "yellowish green."

"Liana," the stout, weak, hollow stem herbaceous at least above, about 8 mm. thick; leaves opposite; petioles stout, broad, 3–8 cm. long, channelled, arachnoid-tomentose beneath, narrowly wing-margined above or throughout, abruptly dilated at base into connate denticulate auricles about 4 mm. high; blades of the larger leaves oblong-ovate, 17–21 cm. long, 6–8 cm. wide, acute, at base broadly rounded to cuneate-rounded, crenate-dentate (teeth about 1 mm. high, 3–6 mm. apart, usually appearing obtuse through the reflexing of the callous tip), above rather pale green, quickly glabrate except along the arachnoid costa, beneath densely and closely whitish- or somewhat ochroleucous-tomentose, penninerved, the chief veins about 12 pairs, slender, scarcely prominulous above, evident beneath and with the secondaries reticulate; upper leaves much smaller (10 cm. long, 3.5 cm. wide), oblong, short-petioled; heads hemispheric, about 2.8 cm. wide in flower and fruit, about 1.5 cm. high, about 7 in a terminal simple cyme and also on 1–3-headed elongate peduncles from the upper axils, the bracts small or minute, the loosely spreading pedicels tomentose, 5–11 cm. long, involucre about 4-seriate, graduate, appressed, the phyllaries oval, oblong, or slightly obovate-oblong, 4–5 mm. wide, glabrous, with substramineous base and shorter to subequal, submembranous, about 11-nerved, broadly rounded tip, receptacle alveolate, the alveolar margins submembranous, lacerate-ciliate, 5 mm. long, rays numerous, bilabiate, long-pilose on tube and back, the tube 4 mm. long, the inner lip linear-acuminate, nerveless, 8 mm. long, the outer bifid to below the middle, 12 mm. long, the lobes unequal in breadth, 2–4-nerved, densely barbate outside below apex (hairs slender-clavate, their cells 2-seriate), disk corollas numerous, 12.5 mm. long (tube very sparsely pilosulous or essentially glabrous, 6.5 mm. long, throat slender-campanulate, 2.2 mm. long, teeth 3.8 mm. long, clavate-glandular on back above, below apex densely barbate with hairs like those of the ray corollas), achenes nearly oblong, brownish, 10-ribbed, 2 mm. long, bearing a very few hairs near tip, pappus brownish, the bristles slender, not dilated at apex, obscurely hispidulous, graduate, the inner 9 mm. long, the outer about 4 mm. long, all fragile and readily deciduous from the very shallow saucer formed by their connate bases.

PERU. "Liana, flowers yellowish green," Muña, trail to Tambo de Vaca, Dept. Huánuco, alt. 2440 m., 5–7 June 1923, *Macbride* 4337 (type no. 535421, Field Mus.; dupl. no. 1,191,497, U. S. Nat. Herb.).

This interesting plant is evidently very closely allied to *L. silphioides* (Poepp.) Blake, but differs in so many details that it seems best to describe it as a new species. *Liabum silphioides* was described as a 3-foot herb with 4-angled stem, proportionately broader and membranous leaves (the lower subcordate), golden flowers, and pappus about half as long as the tube of the disk corollas. The rays of *L. affine*, as described above, suggest those of the Mutisieae, but they are probably abnormal; at any rate those of *L. silphioides*, certainly a very closely related plant, are not so described.

Liabum stenolepis Blake, sp. nov.

Section *Erato*; stem, petioles, and pedicels spreading-hirsute, leaves broadly cordate-ovate, coarsely repand-dentate, slender-petioled; heads numerous, cymose-panicled, long-pedicelled, comparatively large, involucre 12–13 mm. high, the outer phyllaries narrowly lance-triangular, acuminate, with long hispidulous herbaceous tips, the innermost elongate-linear, less than 1 mm. wide.

"Liana;" stem stout (6 mm thick), pithy, obtusely 6-angled, densely spreading-hirsute with tuberculate-based hairs, glabrescent below, leaves opposite; petioles 4–7 cm. long, naked except at base where bearing oblong herbaceous connate auricles 1 cm. long, blades about 12 cm. long, 8–11 cm. wide, acuminate, shallowly cordate at base, coarsely repand-dentate (teeth about 4–7 pairs, deltoid, acute, up to 1 cm high) and remotely callous-denticulate, submembranous, above deep green, beneath somewhat paler, rather densely strigose on both sides and along the veins spreading-hirsute, palmately 7–9-nerved from base; panicle ternately divided, about 25 cm. long and wide, about 24–35-headed, pubescent like the stem, the pedicels mostly 2.5–5 cm long, the bracts small, subulate, disk in fruit 1.8–2 2 cm. wide; involucre broad, about 6-seriate, graduate, the 3–4 outer series of phyllaries elongate-triangular (about 1 5 mm wide), with short, substramineous, sparsely hispidulous base and much longer, loose, acuminate, callous-pointed, herbaceous tips, these hispidulous on both surfaces and ciliolate, the 2 innermost series of narrowly linear, obtuse or acute, 3–5-nerved, substramineous phyllaries (about 0.6 mm. wide), ciliolate, essentially glabrous dorsally; receptacle areolate, glabrous; rays (only immature ones examined) numerous, glabrous, the tube 1.5 mm long, the lamina linear, 6 mm. long, 0.6 mm. wide, 3-nerved, obscurely bidenticulate; disk flowers numerous, their corollas (immature) hirsute at base of throat, hispidulous at tip of teeth, 6.7 mm long (tube 2.6 mm., throat 1.4 mm., teeth 2.7 mm); achenes oblong, 1.5 mm. long, strongly 3 (ray) or 4 (disk)-ribbed, whitish, glabrous or rarely very sparsely hispidulous above; pappus brownish-white, 6 mm. long, of numerous nearly smooth somewhat flattened setae, and a few short similar but more slender outer ones about 1 mm. long

PERU. "Liana, flowers lemon-yellow," Muña, trail to Tambo de Vaca, Dept. Huánuco, alt 2440 m , 5–7 June 1923, *Macbride* 4338 (type no. 535422, Field Mus.; dupl. no. 1,191,498, U. S. Nat. Herb.).

Allied to *L. vulcanicum* Klatt and *L. pallatangense* Hieron., but with considerably longer involucre, the outer phyllaries narrowly linear-lanceolate and rather densely hispidulous dorsally, the inner elongate-linear. The type of *Erato polymnioides* DC., examined by the writer in 1925, is the same species as *L. pallatangense* Hieron De Candolle's name is not available because of the use of the name *Liabum polymnioides* by R E. Fries in 1907 for an Argentinian species.

Liabum tenerum (Sch. Bip) Blake.

Kastnera tenera Sch. Bip. Flora 37: 38. 1853.

COLOMBIA: Cliffs at cascade, La Lora to summit, new Quindio trail, Cordillera Central, Dept. Tolima, 14 Aug 1922, *Killip* 9775.

Mr. Killip's plant agrees so closely with Schultz's careful original description as to leave no doubt of its identity. The type was collected in the same general region ("prov. Cauca pr. Quindiu Paramilla alt. 10,500 ped. Februario 1843: Linden! n. 1136"), and probably, according to information received from Dr. F. W. Pennell, within 10 miles of the spot where Killip collected the species. *Liabum niveum* Hieron is very closely allied, having the same involucre and pappus, but is apparently distinct in its arachnoid-tomentose peduncles and young growth and in the dense white tomentum of the lower leaf surface.

LIABUM HYPOLEUCUM (DC.) Blake, Proc. Biol. Soc Washington 39: 144. 1926.
Vernonia hypoleuca DC. Prodr. 5: 27. 1836.

When transferring this species to *Liabum*, I suggested that it was probably a Peruvian species, although originally described as collected in Mexico by Haenke. Its characters are in the main those of the *L. glabrum* group of Mexico, not those of any South American group, and it now seems probable that the habitat originally recorded was correct.

PALEOBOTANY.—*Cycads in the Shinarump conglomerate of southern Utah.*[1] EDWARD W. BERRY, Johns Hopkins University. (Communicated by J. B. REESIDE, JR.)

The rarity of fossil plants in the Triassic formations of the western United States is my excuse for the following note. In 1921 R. C. Moore made a small collection of plants from the Shinarump conglomerate at a locality 3½ miles east of Wagon Box Mesa and 2 miles east of Water Pocket Canyon in eastern Garfield County, southern Utah. The plants are contained in a brown sandstone or sandy clay-ironstone, and the bulk of the material, including all that is determinable, appertains to a single species.

The collection was reported upon by F. H. Knowlton in a letter dated Oct. 14, 1922, and was said to represent *Otozamites macombii*

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[1] Published by permission of the Director, U S Geological Survey Received April 25, 1927.

Newberry, and *Equisetum* or *Schizoneura* sp. A careful study does not corroborate these tentative determinations. Before describing this material it may be useful to refer to the status of older Mesozoic floras in this general region.

In 1876 Newberry published a description of 14 species of fossil plants in his account as geologist of the Macomb expedition to New Mexico. Of these, *Otozamites macombii* and *Zamites occidentalis* came from the old copper mines near Abiquiu and the balance from the State of Sonora, Mexico. In 1886 Major Powell made a second small collection near Abiquiu, and in 1889 Knowlton made a third collection. These two collections were described in 1890 by Fontaine & Knowlton,[2] who recorded the following additional species: *Equisetum abiquiense* Fontaine, *Equisetum knowltoni* Fontaine, *Zamites powelli* Fontaine, *Cheirolepis munsteri* Schimper, *Palissya brauni* Endlicher (?), *Palissya* cone (?), *Cycadites* (?), *Ctenophyllum* (?), and *Araucarioxylon arizonicum* Knowlton. Ward visited the region in 1899 and 1901 and prepared an elaborate geological report,[3] but added nothing to the paleobotany but the name *Araucarites chiquito* for an obscure cone (?) which has never been described nor figured.

Ward recognized in what he called Powell's "Shinarump formation" two fancied members—the "Leroux beds" above, which includes the so-called "Belodont beds," of Upper Triassic age and referable to the Chinle formation; and a lower, called at first "Shinarump conglomerate" and later the "Lithodendron member," which, he believed, contained all of the abundant petrified wood of the region, and which includes Shinarump conglomerate in the strict sense and a part of the Chinle formation.

Gregory, who carried out extensive field work in the Navajo Country from 1909 to 1913, the results of which are recorded in U. S. Geological Survey Professional Paper 93 (1917), not only summarized the history of exploration of the region, but gave reasons for dropping Ward's terminology and restricting the Shinarump conglomerate to the sense in which it was proposed by Powell.

It seems remarkable that in a region noted for the abundance of silicified wood, some of it in place where it grew, so few traces of foliar parts should be found, especially since all of the wood examined microscopically is coniferous, and coniferous foliage is usually the last type of vegetation to disappear under all conditions of sedimentation.

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[2] W. M. Fontaine and F. H. Knowlton. *Notes on Triassic plants from New Mexico.* Proc. U. S. Nat. Mus., 13: 281–285. *Pls. 22–26.* 1890.

[3] L. F. Ward. U. S. Geol. Surv., 20th Ann. Rept. (2): 315–334. 1900.

My impression is that vast quantities of foliar remains have been entombed, but these have become so oxidized as to have practically disappeared, except locally. I know that in the so-called "Popo Agie beds" of Wyoming, of approximately the same age as the Shinarump, fossil plants are common, but usually so near the vanishing point as to be generally unrecognizable.[4]

Turning now to the plants collected from the Shinarump conglomerate of southern Utah by Mr. Moore, the supposed *Equisetum* or *Schizoneura* is represented by fragments of longitudinally ridged objects, sometimes preserved for lengths of 9 centimeters without showing any nodes. If these fragments represent arthrophytes they could hardly be *Equisetum* since the vascular bundles in that genus normally alternate at the nodes. The genus *Schizoneura* normally has bundles continuous from internode to internode, but in the case of these Shinarump fragments the ridges are not parallel and I therefore conclude that they almost certainly represent fragments of some large-pinnuled cycad.

The abundant and definitive plants from this locality are identical with what Fontaine called *Zamites powelli* from Abiquiu, but since they are not referable to *Zamites* and also were never adequately described, they may be characterized as follows:

Otozamites powelli (Fontaine)

Zamites powelli Fontaine, Proc. U. S. Nat. Mus. 13: 284, *Pls. 25, 26*. 1890.

Fronds exhibiting great variation in the size of the pinnules, not only with respect to their proximal, median or distal positions, but also from frond to frond. Rachis fairly stout, about 2 millimeters in diameter in the only specimen which shows it clearly, slightly flexuous and striated. Pinnules inserted on the top of the rachis, which consequently appears unduly slender when viewed from above. The pinnules are alternate, variously spaced, but on the whole closely spaced; their angle of divergence from the rachis varies from 45° to 90° and although partly explained according to their position in the frond, varies from frond to frond. This is shown by the same sized pinnules in different specimens showing a similar variability. Pinnules coriaceous, linear, slightly falcate, truncately rounded at their tips; the base contracted and more or less retuse, generally equilateral, but occasionally having the distal half more expanded than the proximal half. Veins thin, varying from 15 to 25 per pinnule, radiating from the area of attachment directly to the margins, forking proximad. The lamina between the veins forms raised ridges that give the appearance of stout close-set veins.

The largest fragment in the collection is 13 centimeters long and shows parts of 14 pairs of pinnules. One specimen shows parts of 12 pairs of narrow pinnules 5 millimeters wide, and immediately beside it are fragments of 5 regularly oriented pinnules 12 millimeters wide. One small fragment shows

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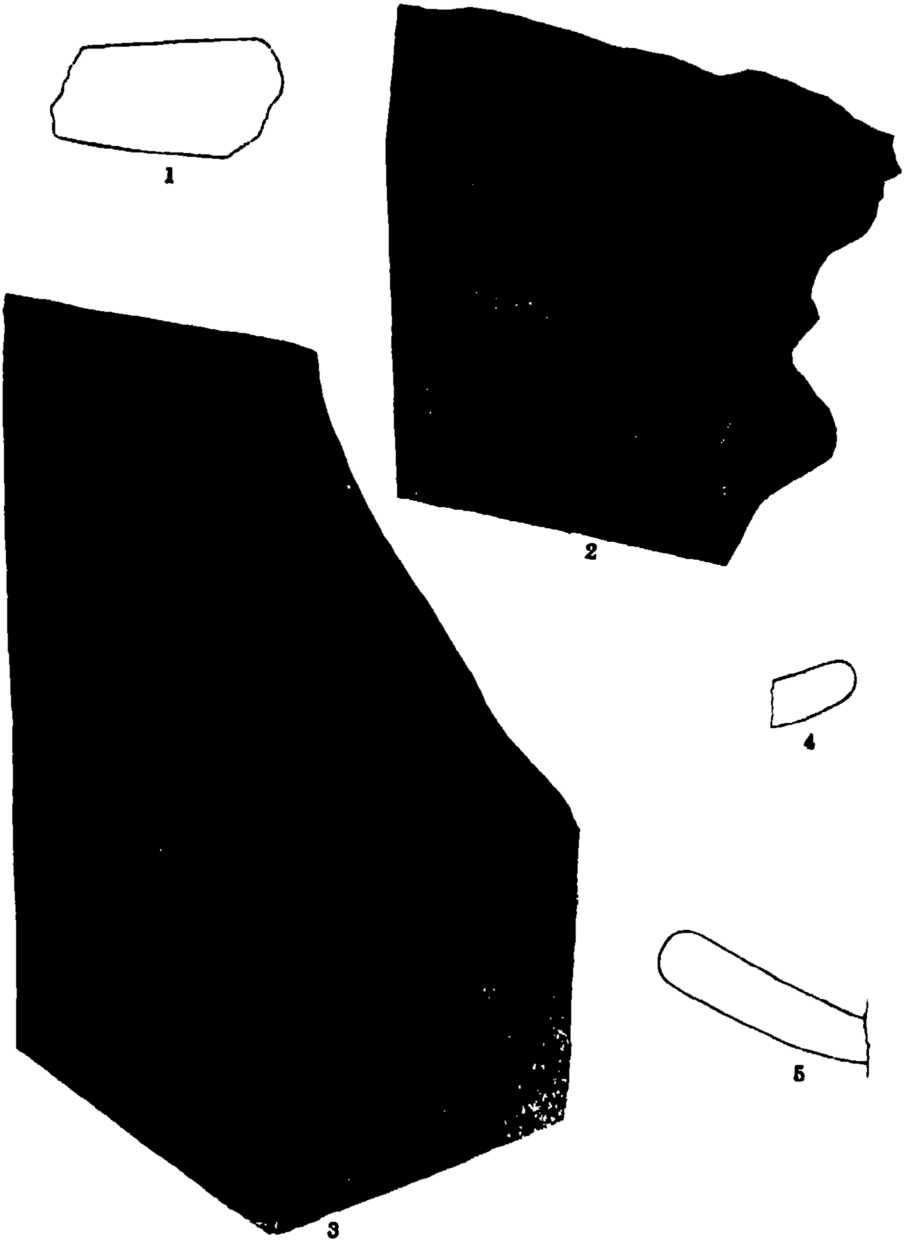
[4] E. W. BERRY. Journ. Geol., 32: 488–497. 1924.



Figs 1–5 *Otozamites powelli* (Fontaine).—1, fragment showing the maximum observed width of pinnules, 2, 3, showing character of the material and general form, with insertion and venation of the pinnules, 4, outline of a basal pinnule (except base); 5, outline of a normal pinnule (except base).

pinnules (presumably distal) between 2 and 2.5 millimeters wide, and other characteristically veined fragments have widths of 1.5 centimeters. In some specimens the pinnules are preserved with their margins incurved as though buried while dry by wind blown sediments.

Otozamites powelli differs from *Otozamites macombii* in the more regular alternate arrangement of the pinnules, those of the two sides inserted closer together on top of the rachis, which is more slender, and in the shape and relative proportions of the pinnules. In Newberry's species they are twice as wide, and range in form from orbicular or reniform to oblong. There is no doubt that a single botanic species might readily show an equal amount of foliar variation, but in the absence of association or intergradation the two must be considered distinct species.

There are various foreign species of *Otozamites*, both in Europe and Asia which resemble the present fossil, mostly from beds believed to be Rhaetic in age, but such long distance comparisons have but slight significance. The only American form which is similar is the variety *intermedius* of *Otozamites hespera* Wieland from the supposed Lias of Oaxaca, southern Mexico.

The problem of the generic limits in fossil cycad fronds is a difficult one, about which students have decided differences of opinion, and this is especially acute as between *Zamites* and *Otozamites*, the former originally including the latter, which was proposed as a sub-genus of *Zamites* by Braun in 1842. The only recent systematic work which discusses this generic difficulty is that of Halle (The Mesozoic Flora of Graham Land, 1913). He restricts *Otozamites* to forms with an asymmetric, auriculate base, the distal lobe more prominently developed than the proximal. Thus defined his *Zamites* includes forms which I would refer to *Otozamites*

Venation, although dependent to a considerable extent upon form, should not be ignored. Naturally the longer and narrower the pinnules, the more nearly will the veins approach parallelism, and in any genus with a contracted area of attachment the veins will converge within such limits, but in *Zamites* none of the veins flare directly to the lower margins as they do in *Otozamites* The auriculation of the base, as the present species shows, may be present or absent among the pinnules of a single frond

SCIENTIFIC NOTES AND NEWS

The Pick and Hammer Club met at the Geological Survey on April 30. Professor WALTER H BUCHER of the University of Cincinnati spoke on the subject of *Continental tectonics*.

The annual field meeting of the Petrologists' Club was held on May 7 in the vicinity of Baltimore, with Prof J T Singewald of Johns Hopkins University as guide.

RESOLUTIONS

The following resolutions on the death of Charles Doolittle Wolcott were adopted by the ACADEMY:

Whereas: there has passed from us one friendly in spirit, wise in counsel, highly eminent in attainments in his chosen fields of geology and paleontology, honored by many universities and learned societies of the world, who in his long life had filled with distinction several of the highest scientific offices of the United States:

Resolved: that the Washington Academy of Sciences hereby records its profound sense of the loss occasioned by the death of its member and former president, CHARLES DOOLITTLE WALCOTT, and its sympathy for his family.

Resolved: that this resolution be spread upon the minutes of the Academy and copies be transmitted to the family and to the Smithsonian Institution.

JOURNAL

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VOL. 17 JUNE 19, 1927 No. 12

BOTANY.—*New plants from Central America.*—IX. PAUL C. STANDLEY, U. S. National Museum.[1]

On the following pages are described thirteen new Central American plants, chiefly trees and shrubs. Of special interest are the two new species of *Weinmannia*, representatives of a genus of trees of which only a single species has been known previously from Central America.

There is included in the present paper a description of a new species of *Hybanthus* from western Mexico.

Weinmannia Wercklei Standl., sp. nov.

Usually a large shrub or small tree but sometimes (according to Wercklé) a large tree, the older branchlets slender, terete, dark reddish brown, the young ones compressed, densely puberulent, with short or elongate internodes; stipules soon deciduous, oval, 3–5 mm. long, broadly rounded at apex, green, glabrous within, sparsely or densely sericeous or strigillose outside; leaves simple, the petioles 2–3 (rarely 10) mm long, puberulent or glabrous, leaf blades lance-oblong to ovate-oblong, mostly 3.5–5.5 cm. long and 1.2–2.3 cm. wide (on young sterile branches up to 12 by 6 cm.), acute or acuminate, acute at base, rather coarsely crenate-serrate, subcoriaceous, deep green above, glabrous, beneath paler, often brownish when dried, sparsely pilose, at least along the costa, with short appressed hairs, in age glabrate, the costa slender, prominent beneath the lateral nerves about 13 on each side, inconspicuous, nearly straight, extending to the margin, racemes terminal and axillary, pedunculate, densely many-flowered, the rachis 2–3 cm long, puberulent, the pedicels slender, fasciculate, 2–5 mm long, puberulent; calyx 5-parted, sparsely puberulent or glabrate, scarcely more than 1 mm. long, the lobes ovate, acute; filaments glabrous, ovary narrowly ovoid, densely whitish-pubescent, the styles glabrous, 1 mm long.

Type in the U.S. National Herbarium, no. 678753, collected at San Cristóbal de Candelaría, Province of Cartago, Costa Rica, altitude 1,700 meters, by C. Wercklé (*Pittier* no. 3685). The following sterile specimens are conspecific:

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[1] Published by permission of the Secretary of the Smithsonian Institution For the last preceding paper of this series see page 245 of this volume of The JOURNAL Received March 30, 1927.

COSTA RICA: La Palma, Province of San José, alt. 1,450 m., *Biolley & Tonduz* 12513; *Standley* 37990. Cerros de Zurquí, Province of Heredia, alt. 2,200 m., *Standley & Valerio* 50589. El Muñeco, Province of Cartago, alt. 1,500 m., *Standley & Torres* 51140. Santa María de Dota, Province of San José, alt. 1,800 m, *Standley* 41581.

Only one species of *Weinmannia*, *W. pinnata* L., with pinnate leaves, has been known heretofore from Central America. In its foliage characters *W. Wercklei* resembles *W. lamprophylla* Hieron., of Colombia, which has a glabrous ovary.

Weinmannia burseraefolia Standl., sp. nov.

Tree, the older branchlets blackish, with short internodes, glabrous; stipules broadly oval, persistent and recurved, green, coriaceous, glabrous; leaves pinnate, the petiole 1.5–1.8 cm long, sulcate on the upper surface, glabrous, narrowly margined above, the rachis 3.5–4 cm. long, sparsely short-barbate at the nodes, elsewhere glabrous, narrowly winged between the lobes, the wings entire, 2–4 mm. in (combined) width, leaflets 9, oblong-elliptic to ovate-elliptic, 2.2–3.5 cm. long, 1–1.4 cm. wide, acutish to acuminate, sessile, the lateral ones oblique at base and acutish, the terminal one acuminately contracted at base, leaflets coriaceous, finely appressed-serrate, (serrations about 11 on each side), glabrous, lustrous above, slightly paler beneath, the costa very slender, prominent on both surfaces, the other venation inconspicuous

Type in the U S National Herbarium, no. 1,306,224, collected in wet forest at Yerba Buena, northeast of San Isidro, Province of Heredia, Costa Rica, altitude 2,000 meters, February 28, 1926, by Paul C. Standley and Juvenal Valerio (no. 49848).

At the time of collecting the specimens the tree was recognized as distinct from the common *Weinmannia pinnata*, but it was impossible to discover fertile branches. Although the material is sterile, I have little hesitancy in describing it as a new species. From *W. pinnata* it differs in its acute, glabrous, closely serrate (not crenate) leaflets. In general appearance *W. burseraefolia* somewhat suggests *W. crenata* Presl, of northern South America.

Alchemilla pascuorum Standl., sp. nov.

Sarmentose perennial, the stems 10–30 cm. long, procumbent, often rooting at the nodes, with elongate internodes, slender, hirsute with long, slender, chiefly appressed hairs, basal and lower stem leaves slender-petiolate, the uppermost leaves sessile or short-petiolate, stipules connate into a sheath, cleft into narrowly oblong, green, sericeous lobes, lower petioles 2 cm. long or shorter, appressed-hirsute; leaf blades reniform, 2–4 cm. wide, deeply cleft into 5–7 lobes, these broadly cuneate-obovate, rounded at apex, deeply serrate above the middle, with narrow, obtuse or acutish teeth, green on the upper surface and sparsely sericeous, beneath grayish green, rather densely sericeous with long, slender, closely appressed hairs; blades of the uppermost leaves deeply 3-lobed; flowers green, cymose, in small dense clusters near or at the ends of the branches, the pedicels 1.5 mm. long or shorter; hypanthium globose-urceolate, 1.5 mm. long, densely sericeous; sepals and bractlets erect, subequal, 0.6 mm. long, the bractlets lanceolate, the sepals lance-ovate, acute or acutish, sparsely sericeous or glabrate; achenes broadly ovoid, obtuse, somewhat compressed, 1 mm. long, dark brown, nearly smooth.

Type in the U. S. National Herbarium no. 1,228,245, collected in wet meadow at Las Nubes, Province of San José, Costa Rica, altitude about 1,800 meters, March 21, 1914, by Paul C. Standley (no. 38455).

This plant is frequent in the pastures of the high mountains of central Costa Rica, and the following collections may be cited:

COSTA RICA: Southern slope of Turrialba Volcano, near Finca del Volcán de Turrialba, alt. 2,000–2,400 m., *Standley* 35028, 34940. Las Nubes, *Standley* 38386. Río Birrís, *Standley* 35416. Fraijanes, alt. 1,600 m., *Standley & Torres* 47627.

On Turrialba the plant is called "mochililla." Like the other species, it is grazed by cattle

Alchemilla pascuorum is a near relative of *A. venusta* Cham. & Schlecht., of Mexico and Guatemala, but in that the stems are hirsute with spreading hairs, and the leaves also are loosely hirsute

ALCHEMILLA SUBALPESTRIS Rose, Contr. U. S Nat. Herb. 10: 96. 1906

This species, known previously only from Mexico, may be reported from Costa Rica It was collected near Finca La Cima, above Los Lotes, north of El Copey, altitude 2,100 meters, in December, 1925, *Standley* 42551.

ACAENA CYLINDROSTACHYA Ruiz & Pavón, Fl. Peruv. 1: *68, pl. 104, f. 2.* 1798

This species, apparently common in the central and northern Andes of South America, may now be reported from Costa Rica. It was collected by the writer (*Standley & Valerio* 43639, 43682) on Cerro de las Vueltas, Costa Rica, at 3,000 meters, in December, 1925. It is frequent in the paramos of this high peak Although not a very conspicuous plant, it attracts attention because of its handsome leaves with beautiful silky pubescence. One other species of the genus, *Acaena elongata* L., is common in the higher mountains of Central America, and ranges northward to Mexico

Oxalis Maxonii Standl., sp nov.

Plants woody or suffrutescent, branched, ascending or recumbent, the branches up to 1 m. long, red-brown, pilose with short, straight, mostly appressed hairs and puberulent with short curved hairs, the internodes short or elongate, leaves palmately 3-foliolate, the petioles very slender, 1.5–5 cm. long, pilose with slender, ascending or appressed, whitish hairs; leaflets short-petiolulate, the petiolules less than 2 mm. long, pilose with stiff spreading white hairs, the blades ovate or broadly ovate, 2–4.5 cm. long, 1.2–2 3 cm. wide, acute to very obtuse at apex, obtuse to rounded-obtuse at base, the lateral leaflets asymmetric, smaller and more obtuse than the terminal one, thin, green and glabrous on the upper surface, ciliate, beneath paler, thinly appressed-pilose with slender hairs, often glabrate; cymes slender-pedunculate, about equaling the leaves, 2 to 4-flowered, the bracts linear, about 4 mm. long, the pedicels proper 2–3 mm long, minutely appressed-pilose, shorter than the slender peduncles, the bractlets linear, minute; sepals 4.5–5 mm. long, lanceolate, acute or obtuse, erect, thinly pilose with short slender white appressed hairs, thin, greenish; petals yellow, 1.5 cm. long, rounded at apex, glabrous; filaments 7 mm. long, densely pubescent; styles densely pubescent; capsule (immature) oval-globose, 4 mm. long, densely pubescent with short slender whitish ascending hairs.

Type in the U. S. National Herbarium, no. 675390, collected in brushy undergrowth near the river, El Boquete, Chiriquí, Panama, altitude 1,000 to 1,300 meters, March, 1911, by William R. Maxon (no 4996). Here are referred the following additional collections from Chiriquí:

PANAMA Along river in shade, El Boquete, *Pittier* 2970. Woods along Griffen Trail, Horqueta Mts , alt. 1,700 m , *Killip* 3527.

In general appearance this is like *O acuminata* Schlecht. & Cham., of Mexico and Guatemala, but in the latter the flowers are smaller, and the long-acuminate leaflets are pubescent on the upper surface.

Picramnia longifolia Standl., sp. nov.

Shrub 2.5–3 m high, the young branches slender, at first sparsely and minutely puberulent, densely leafy; leaves 17 to 21–foliolate, the petiole 2–3 cm. long, the rachis 14–20 cm. long, sparsely puberulent or glabrate, the leaflets alternate, rather distant, the petiolules 2–3 mm. long, puberulent; leaflets obliquely ovate to oblong-ovate or (the lowest) broadly ovate, 3–4.5 cm. long, 1–2 cm. wide, rather abruptly acuminate or long-acuminate to an obtuse tip, at base very oblique, acute on one side, obtuse or rounded on the other, deep green above, slightly paler beneath, sparsely and minutely puberulent on the costa, elsewhere glabrous; staminate inflorescence pedunculate, about 20 cm. long, the rachis sparsely puberulent, the inflorescence much interrupted, the glomerules sessile and distant, the panicle branched near the base, the branches 5–10 mm. long, the bracts about equaling the glomerules; staminate flowers scarcely 1.5 mm. long, short-pedicellate, 4-parted, glabrous or nearly so, the sepals oval; pistillate racemes (in fruit) pedunculate, 10–12 cm. long, simply racemose, the rachis very sparsely puberulent, the pedicels solitary or fasciculate, stout, 5–8 mm. long, glabrate, divaricate or ascending; sepals 4, rounded, persistent and spreading in fruit, minutely and densely appressed-pilose; fruit dark red, obovoid-globose, about 1 cm. long and 8 mm. thick, rounded at apex, glabrous.

Type in the U. S. National Herbarium, no. 1,307,021, collected in wet forest on Cerro de las Caricias, north of San Isidro, Province of Heredia, Costa Rica, altitude about 2,400 meters, March 11, 1926, by Paul C. Standley and Juvenal Valerio (no. 52211). No. 52108, from the same locality, belongs to this species.

Related to *P. quaternaria* Donn Smith, the most abundant *Picramnia* of Costa Rica, which differs in its less numerous leaflets and simple staminate inflorescences.

Hybanthus serrulatus Standl , sp. nov.

Plants herbaceous or suffrutescent (only upper part of plant at hand), about 60 cm. high, the branches green, sparsely or densely incurved-puberulous; leaves alternate, the stipules subulate, 1.5–2 5 mm. long, the petioles 4–8 mm. long, puberulent; leaf blades ovate, the larger 5 cm. long and 2.3 cm. wide, acuminate, obtuse to acute at base, thin, finely and closely crenate-serrate to the base, finely villosulous above with whitish hairs, beneath slightly paler, incurved-puberulous, especially on the nerves; flowers numerous, in racemes terminating short or elongate axillary branches; racemes 4 cm. long or shorter, the pedicels 4–6 mm. long, widely ascending, finely puberulent, the bracts leaflike, lanceolate, 1.5 cm. long or shorter, those at the base of the pedicel filiform and stipule-like; sepals broadly ovate, obtuse, nearly 2 mm. long, green, densely scaberulous-puberulent; lower petal 2.7 mm. long, densely puberulent outside, narrowly spatulate, the blade much shorter than the claw, the other petals about equaling the sepals, capsule rounded-ovate, 3 mm. long, scaberulous, minutely rostrate at apex, seeds ochraceous

Type in the U S. National Herbarium, no. 386032, collected in clay soil in the Sierra Madre of Michoacán or Guerrero, Mexico, altitude 1,100 meters, November 4, 1898, by E. Langlassé (no. 558).

Related to *H. fruticulosus* (Benth.) Johnston, of Lower California, in which the much narrower leaves are remotely and unequally dentate or subentire.

Begonia Torresii Standl, sp. nov.

Plants perennial, erect (the base sometimes decumbent), 25–40 cm high, branched, the branches few, ascending, short or elongate, succulent, short-villous or glabrate, stipules oblong to ovate, about 1 cm. long, obtuse, green, glabrous, tardily deciduous, petioles slender, 4–15 mm long, short-villous, leaf blades oblong or ovate-oblong, sometimes broadest near the apex, 2 5–7 cm long, 1–3 cm wide, obtuse to acuminate, oblique at base, rounded on one side, very acute on the other, irregularly duplicate-serrate, often coarsely so, or laciniate-serrate, especially near the apex, the teeth usually setose-mucronate, at first often copiously short-villous on both sides but in age usually glabrate; peduncles 1 or few-flowered, slender, erect, equaling or longer than the leaves, glabrous, or sparsely villous below; flowers pink; bracts oval, 4–6 mm. long, green, glabrous; staminate sepals oval, 6 mm long, glabrous, exceeding the petals; capsule green, glabrous, 2 cm. long and wide, rounded at base, abruptly contracted above into a stout beak 1 cm. long, the body of the capsule 3-lobed, the lobes divaricate, triangular, abruptly contracted into a short horn.

Type in the U. S National Herbarium, no. 1,228,283, collected in wet forest at Las Nubes, Province of San José, Costa Rica, altitude about 1,900 meters, March 21, 1924, by Paul C. Standley (no. 38561). The following additional collections may be cited

COSTA RICA· Las Nubes, *Standley* 38599, 38523, 38640, 38816. Southern slopes of Turrialba Volcano, near the Finca del Volcán de Turrialba, alt. 2,400 m., *Standley* 35338.

The species is named for Prof. Rubén Torres Rojas, in whose company part of the material was collected. *Begonia Torresii* belongs to the section *Casparya* (sometimes recognized as a distinct genus), and is related to *B. urticae* L.f., of Colombia. It is probably the plant reported from Costa Rica by A. De Candolle[3] as *Casparya urticae* γ *hispida*, although the description does not agree very well. The Colombian *B. urticae* differs from *B. Torresii* in its thicker, more obtuse and more densely pubescent, short-petioled leaves, and in its pubescent fruit.

Begonia Valerii Standl., sp. nov.

Erect herb, 1–1 5 m. high, the stem stout, leafy above, usually simple, densely pilose with soft spreading brownish several-celled hairs; stipules lanceolate to ovate, 1.5–2 cm. long, attenuate, densely brown-pilose, soon deciduous; petioles slender, 8–17 cm. long, brown-pilose; leaf blades broadly oblique-ovate, 16–26 cm. long, 9–16 cm. wide, abruptly cuspidate-acuminate, very oblique at base and deeply cordate, densely, finely, and unequally dentate, thin, deep green above, thinly pilose with long spreading hairs or glabrate, beneath slightly paler, thinly pilose, especially on the nerves, with long, rather stiff, spreading hairs, about 10-nerved at base; peduncles 20–30 cm. long, thinly pilose, exceeding the leaves, the cymes lax or dense, several times dichotomous, many-flowered, 7–20 cm. broad, the branches sparsely pilose, the flowers umbellate at the ends of the branches; pedicels 5–15 mm. long, very slender, sparsely pilose, flowers white or pinkish; staminate flower with 2 sepals, these suborbicular, about 7 mm. long and wide, rounded at apex, rounded to subcordate at base, glabrous outside or sparsely pilose near the base; petals none; filaments united at base; capsule 3-lobed, 6 mm. long, sparsely pilose or glabrate, 2 of the wings very narrow, the third oval-oblong, horizontal, rounded at apex, about 1 cm. wide.

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[3] Prodr. 15¹: 274 1864

Type in the U. S. National Herbarium, no. 1,254,000, collected in wet forest at El Arenal, Guanacaste, Costa Rica, altitude about 500 meters, January 19, 1926, by Paul C. Standley and Juvenal Valerio (no. 45245). The following collections also are referred here:

COSTA RICA. El Arenal, *Standley & Valerio* 45287. Pejivalle, Province of Cartago, *Standley & Valerio* 46885, 46963, 47112.

In general appearance this resembles *B. involucrata* Liebm., which has glabrous pedicels and usually lobed leaves. *B. Biolleyi* C. DC., also closely related, is separated by its much more copious pubescence, that of the lower surface of the leaves consisting of long matted hairs.

Begonia Carletonii Standl., sp. nov.

Plants small, with short, densely leafy rootstocks 2–3 mm. thick, emitting numerous long fibrous roots and also slender stolons; stolons rooting at the nodes and bearing a single leaf, sometimes also a peduncle, at each node, the internodes 5–8 cm. long, sparsely setose-pilose, stipules lanceolate, about 9 mm. long, attenuate, persistent, thin, brown, pilose; petioles slender, 3.5–5 cm. long, pilose with long slender spreading brown hairs, leaf blades obliquely ovate, 6–9.5 cm. long, 2.7–5 cm. wide, long-acuminate, oblique at base and shallowly cordate, the basal lobes broadly rounded, palmately 8-nerved at base, the central nerve 3 times dichotomous, thin, sparsely setose-pilose on both surfaces, green above, paler beneath, the margin closely, finely, and unequally sinuate-dentate; peduncles equaling the leaves, 2 or 3-flowered, very slender, sparsely pilose; bracts and bractlets ovate or oblong, obtuse, 3 mm. long or shorter, erect, persistent, ovary densely villous; staminate flowers slender-pedicellate, the 2 sepals rounded-ovate, 6 mm. long, rounded-obtuse, rounded at base, sparsely pilose, the petals oblong-spatulate, 6 mm. long, rounded at apex, glabrous; capsule 7 mm. long, sparsely pilose, the 3 wings very unequal, the largest 6 mm. broad, obtuse, divaricate.

Type in the U. S. National Herbarium, nos. 1,081,658–659, collected in the region of Bocas del Toro, Panama, April 22, 1921, by M. A. Carleton (no. 206).

This begonia, although a small and inconspicuous plant, is exceptionally neat in appearance. It is not closely related to any Central American species with which I am acquainted.

Oreopanax Donnell-Smithii Standl., sp. nov.

Tree, the young branches very thick, densely leafy, densely stellate-tomentose; bud scales densely tomentose; petioles slender, 6–21 cm. long, glabrous; blades of the larger leaves cordate-suborbicular to rounded-ovate, 19–24 cm. long, 16–18 cm. wide, rounded or very obtuse at apex, broadly rounded at base and shallowly cordate (sinus narrow, 1–1.5 cm. deep), chartaceous, entire, glabrous, deep green above, pale beneath, 5-nerved at base (with 2 inconspicuous slender lower nerves), blades of the leaves at base of inflorescence smaller, broadly ovate to oval, rounded at apex, broadly rounded or emarginate at base; panicles large, pyramidal, 20–30 cm. long and broad, the branches stellate-pubescent with minute ochraceous hairs, bracts 1–1.5 mm. long, triangular, divaricate; staminate flower heads dense, many-flowered subglobose, 5 mm. in diameter, forming lax racemes 5–13 cm. long, the peduncles stout, divaricate, 5–8 mm. long, stellate-pubescent; bractlets broad, rounded at apex, glabrate, ciliolate, corolla lobes 1.5 mm. long, ovate, obtuse; filaments slender, exceeding the corolla, the anthers oval, 0.8 mm. long.

Type in the U. S. National Herbarium, no. 355151, collected at Atirro, Province of Cartago, Costa Rica, altitude 600 meters, April, 1896, by John Donnell Smith (no. 6533). Here may be referred the following collections.

COSTA RICA: Río de las Vueltas, Tucurrique, alt. 635 m., *Tonduz* 13120 bis. Orosi, alt. 1,000 m., *Pittier* 1764.

This tree is a relative of *O. capitatum* (Jacq.) Decaisne & Planch., which has much narrower leaves. *Oreopanax Donnell-Smithii* resembles also *O. costaricense* March., but in that the inflorescence is glabrous.

Oreopanax nubigenum Standl., sp. nov.

Tree 6–10 m. high, the branchlets thick and stout, densely leafy, very sparsely stellate-pubescent or glabrous; scales of the leaf buds rounded, glabrous, ciliate, the stipule-like bracts enveloping the budding inflorescence as much as 6 cm. long, glabrous; petioles slender, 3.5–17 cm. long, glabrous; leaf blades broadly deltoid-rounded, often as broad as long, sometimes rounded-rhombic, 7.5–15 cm. long and broad, acute or abruptly acute, rarely obtuse, at base varying from truncate to obtuse but often very broadly cuneate, entire, coriaceous, glabrous, 5-nerved at base; fruiting panicles 9–17 cm. long, rather dense, the branches stellate-pubescent, the bracts 1.5–3 cm. long, triangular, acute, ciliate, divaricate, fruiting heads very numerous, containing 4–8 fruits, the peduncles stout, divaricate, 8–13 mm. long, stellate-pubescent; fruits subglobose, 5 mm. long, 6 or 7-celled, glabrous.

Type in the U. S. National Herbarium, no. 1,228,409, collected in wet forest at Las Nubes, Province of San José, Costa Rica, altitude, 1,800 meters, March 21, 1924, by Paul C. Standley (no. 38806). Represented also by the following collections:

COSTA RICA: Las Nubes, *Standley* 38711. Cerros de Zurquí, Province of Heredia, alt. 2,200 m., *Standley & Valerio* 50808.

This, also, is a relative of *O. capitatum* and of *O. Donnell-Smithii*. From the latter it is distinguished by the acute leaves, which are not cordate at base.

Sciadophyllum nicaraguense Standl., sp. nov.

Shrub 2.5 m. high; petiole 40 cm. long, stout, terete, obscurely strigillose or glabrate; petiolules stout, 4.5–13 cm. long, glabrate; leaflets (4 present on the single leaf available) oval-oblong, 24–32 cm. long, 9.5–15 cm. wide, broadly rounded at apex and caudate-cuspidate, the acumen 2–2.5 cm. long, attenuate, at base rounded, pergamentaceous, entire, concolorous, glabrous above or nearly so, somewhat lustrous, beneath dull, sparsely pubescent with minute appressed hairs, the costa and lateral nerves salient on both surfaces, the lateral nerves about 19 on each side, divaricate, curved near the margin and irregularly anastomosing, the ultimate nerves prominulous, closely reticulate; rachis of the inflorescence (only fragments present) ferruginous-tomentulose, the bracts deciduous, umbels few-flowered, the peduncles 6–8 mm. long, the pedicels about 3 mm long, ferruginous-tomentulose; ovary tomentulose; calyx nearly 2 mm. broad, disk annular, fleshy, styles connate into a conic column nearly 2 mm. long.

Type in the U S. National Herbarium, no. 1,082,152, collected at San Juan del Norte, Nicaragua, March 2, 1893, by C. L. Smith (no. 78).

Only incomplete material is available for study, but this is sufficient to prove the plant a distinct species. Only one other member of the genus, *S. systylum* Donn. Smith, is known from Central America It grows in the mountains of Costa Rica. The flowers of *S nicaraguense* resemble those of *S systylum*, but the latter plant has copious stellate pubescence

Dendropanax monticola Standl., sp. nov.

Tree 4 5–6 m. high, glabrous throughout, the older branchlets ochraceous; petioles slender, 1.3–6 cm. long; leaf blades ovate or elliptic-ovate, 7–13.5 cm. long, 2.5–6 cm wide, acuminate or long-acuminate, rounded or very obtuse at base, pergamentaceous, entire, deep green above, slightly paler beneath, triplinerved, the lateral nerves 4 or 5 on each side, divergent at an angle of about 55 degrees, arcuate, slender, irregularly anastomosing close to the margin, the costa very slender; umbels few, few-flowered (flowers about 10), arranged in a terminal short-pedunculate umbel or in a short raceme; rachis of the raceme 1.6–4 cm. long, the umbels on peduncles 1 8–4 cm. long, the peduncles naked, pedicels 4–7 mm. long; ovary turbinate, nearly 2 mm. long, the calyx entire or remotely denticulate; petals green, obtuse or rounded at apex, 1.5 mm. long, stamens shorter than the petals, fruit not seen.

Type in the U. S. National Herbarium, no. 1,305,191, collected in wet forest near Fraijanes, Province of Alajuela, Costa Rica, altitude about 1,600 meters, February 12, 1926, by Paul C Standley and Rubén Torres Rojas (no. 47538). The following collections represent the same species.

COSTA RICA· Fraijanes, *Standley & Torres* 47418. Cerro de las Caricias, Province of Heredia, alt 2,000–2,400 m., *Standley & Valerio* 52051. La Ventolera, southern slope of Volcán de Poás, *Standley* 34687.

The nearest relative of this tree is *D. querceti* Donn. Smith, also Costa Rican, which has usually solitary umbels, and leaves which are broadest at or above the middle and narrowed at base.

Dendropanax praestans Standl., sp. nov.

Small tree, the branchlets stout, ochraceous, glabrous, densely leafy at the ends, the internodes very short; stipules very small, scarious, the margins laciniate; leaves dimorphous, those of some branches merely dentate, those of other branches all or nearly all digitately trilobate, the petioles slender, 2–7 cm. long, glabrous; blades of the simple leaves ovate-oblong to ovate, 8.5–12.5 cm. long, 3.5–6 cm. wide, acuminate, at base obtuse or broadly cuneate, irregularly sinuate-serrate, the teeth obtuse, a few of them often much larger than the others, the leaves entire near the base or below the middle, 3-nerved at base, the lateral nerves about 5 on each side, arcuate-ascending, lobed blades about 13 cm. long and broad, broadly cuneate at base, lobed to within 3 cm. of the base, the lobes narrowly oblong, about 2 cm. wide, attenuate to apex, irregularly sinuate-serrate, the sinuses between the lobes rounded, leaves all subcoriaceous, glabrous, deep green above, paler beneath, minutely punctate, the venation prominent beneath, umbels many-flowered, arranged in a short-pedunculate terminal umbel, the peduncles of the ultimate umbels stout, 1.5–2 cm. long, naked or bearing near the base a short cuplike sheathing bract; pedicels stout, 4–5 mm. long, sparsely and minutely puberulent or glabrate, hypanthium hemispheric, the calyx very short, 3 mm. broad; petals triangular-oblong, acute, glabrous, 2–2.5 mm. long, stamens shorter than the petals, the filaments short, subulate, fruit subglobose, 5-celled, 5–6 mm. broad, glabrous, styles united for half their length

Type in the U. S. National Herbarium, no. 677609, collected in wet forest of Cuesta de las Palmas, southern slope of Cerro de la Horqueta, Chiriquí, Panama, altitude 1,700 to 2,100 meters, March, 1911, by H. Pittier (no 3213).

Here belong, probably, leaf specimens collected by myself (no. 41973) at Laguna de la Escuadra, northeast of El Copey, Costa Rica, at about 2,100 meters. These leaves are very large, about 30 cm long, and deeply 5-lobed, the lobes coarsely serrate, or the terminal one pinnately lobed.

Among all the other North American species of *Dendropanax* (*Gilibertia*) this may be recognized at once by the toothed leaves.

ZOOLOGY.—*A new genus and species of frog from Tibet.*[1] LEONHARD STEJNEGER, U. S. National Museum.

In his Monograph of the South Asian, Papuan, Melanesian, and Australian Frogs of the genus *Rana*, Boulenger[2] described (p. 107) a series of ten frogs from Southern Tibet under the name of *Rana pleskei* (Guenther). The three localities: Lake Yamdok, 15,000 feet altitude, Kamba Jong [Kampadzong], and Gyantse are situated south of the Brahmaputra on the north slope of the Himalayas, north of the frontiers of Sikkim and Bhutan. Guenther's types came from western Szechwan, China.

The National Museum having recently received from the Rev. D. C. Graham good material of the true *Nanorana pleskei* and also, in exchange with the British Museum through the kindness of H. W. Parker, two specimens from Tingri, Tibet, not far from the general region whence came Boulenger's material, I am in a position to affirm that the latter belongs to a new species totally different from Guenther's species. In further confirmation, Dr. Thomas Barbour was kind enough to lend me for comparison a specimen from Yatong [Yathung] in the projecting angle of Himalayan Tibet between Sikkim and Bhutan.

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[1] Received May 7, 1927.

[2] Rec. Indian Mus. 20: 1–226. 1920.

Altirana, new genus

Diagnosis.—"Vomerine teeth, if present, much reduced; no tympanum; no stapes; fingers and toes not dilated at the tips; outer metatarsals separated by web in their distal third or fourth only; zygomatic branch of the squamosal short; omosternal style not forked at the base; terminal phalanges obtuse." (Boulenger.)

To this should be added that the precoracoid is as well developed as in *Rana* typified by *R. temporaria.*

Altirana parkeri, new species

Diagnosis.—Digits without terminal dilatations and horizontal grooves; tympanum absent; outer metatarsals separated in their distal third, no dorsolateral glandular fold; no long tooth-like protruberance in front of lower jaw; toes fully webbed; subarticular tubercles present but rather flat and indistinct; fifth toe slightly shorter than third; second and fourth fingers subequal; tibiotarsal articulation reaching the shoulder.

Type-locality.—Tingri, Tibet, at 15,000 feet altitude.

Type.—U. S. National Museum, No. 72328.

Measurements	U S N M No 72328 ♂ ad *Millimeters*	M C Z No 11636 ♂ ad. *Millimeters*
Tip of snout to vent	25 00	34 00
" " " " anterior border of eye	5 50	5 75
" " " " nostril	3 25	3 75
Nostril to eye	2 25	2 25
Longitudinal diameter of eye	3 60	4 00
Distance between nostrils	3 00.	3 00
Interorbital width	2 00	2 00
Width of upper eyelid	2 50	3 00
Width of head	12 25	12 00
Fore leg	16 00	16 00
Hind leg from vent to tip of fourth toe	44 00	44 00
" " " groin " " " " "	43 00	42 00
Tibia	14 00	14 00
Foot from heel to tip of fourth toe	26 00	23 00

In view of Boulenger's careful account of the Himalayan specimens a detailed description of the type is not deemed necessary here, but I would call attention to the fact that Boulenger expressly states (p. 108) that males are "without secondary sexual characters," while the specimens before me clearly demonstrate the presence of a large nuptial pad-like swelling on the inner side of the first finger which is covered with minute dark spinules, as are also the bases of the first and second fingers, a feature strongly developed in the Museum of Comparative Zoology specimen, and only slightly less in the type. The inference is that Boulenger's specimens were not collected during the breeding season.

Boulenger's reference of *Nanorana pleskei* to the genus *Rana* and especially his statement that the pectoral arch is as in *Rana temporaria*, which has strong and well ossified precoracoids, and that the tympanum is completely suppressed, undoubtedly misled Dr. Vogt into instituting the genus *Montorana*, with the species *M. ahli*, for specimens possessing a tympanum and having the precoracoid "very weak, thin as a thread, only imperfectly ossified." As a matter of fact, Vogt's *Montorana ahli* is the true *Nanorana pleskei*. Dr. Tsarevski, who at my request examined the types of the latter, writes me that the precoracoid "is very slender, very thin, with slight ossification."

It is consequently plain that Boulenger's *Rana pleskei*, which he regards as forming a distinct subgenus *Nanorana*, does not belong to it at all He considers it as "a very aberrant species," "as a dwarfed, degraded form derived from the *Rana liebigii* group with which it is connected to a certain extent by *R. blanfordii*." It is quite possible that Boulenger is correct in this phylogeny, but the characters and combination of characters indicated in the diagnosis of his subgenus, and which I have adopted for the genus as above, are sufficient to set it off by itself from the rest of the unwieldy genus *Rana*

I have named the species for Dr. H. W. Parker, in charge of the herpetological collection of the British Museum, in recognition of his help in clearing up important points connected with this investigation.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

950TH MEETING

The 950th meeting was held at the Cosmos Club, February 5, 1927.

Program: N. H. HECK, *Observations while passing through an unusual waterspout formation on the Pacific Ocean.* The paper describes observations in the Pacific Ocean of water spout phenomena while actually in the formation by one who is not a meteorologist but who has had occasion during survey work in small craft to watch the weather very closely. Four spouts are described. The first was normal and of the type ordinarily seen. The second was very large, probably 1000 feet in diameter, forming a cylinder dropping from the clouds. With the spout complete the spray could be seen rising and falling on the edge of the spout as in a fountain, at least 600 feet above the surface of the sea. Surface of the sea was broken water after the spout disappeared instead of regular waves due to wind. The third spout was seen in process of formation when directly under cloud in which it was forming and it was seen that it formed between bands of cloud moving in opposite directions Fourth spout was very unusual. The spout tried to form and failed and series of bands of clouds reaching to sea surface from the cloud revolved around the axis of a cylinder remaining nearly vertical and parallel to each other. (*Author's abstract*).

The paper was discussed by Messrs. HEYL, HUMPHREYS, HAWKESWORTH, and AULT

W. J. HUMPHREYS, *The tornado.* The tornado is far more frequent in the central and southeastern portions of the United States than in all the rest of the world. In tropical regions it is unknown It occurs in the warm section of the cyclone more or less east of the windshift line.

In those portions of the United States where tornadoes are most frequent it appears that anticyclonic winds frequently overrun lower cyclonic winds, and produce a windshift line in midair independent, and well ahead, of the surface shift. This necessarily leads to strong local convections starting from this higher level, and at or near the boundary between the two systems of wind, cyclonic and anticyclonic Furthermore, although the courses of these two winds over the earth cross each other, one being from the southwest, say, the other from the northwest, perhaps, nevertheless, if both are moving eastward with the same velocity, as may be the case, with reference to each other they will be moving in exactly opposite directions. That is, they will be flowing beside each other—not through or above and below each other— whatever their respective directions over the earth beneath. Convection between two such currents, dragging in material from each, necessarily produces rotation, and always in the same sense as that of the cyclone.

In short, then, the tornado is a joint product of cyclone and anticyclone generated by convection along a mid-air windshift line. It does not occur in tropical regions because there the anticyclone is unknown (*Author's abstract*)

The paper was discussed by Messrs FERNER, FRANKENFIELD, HECK, CROOK, TUCKERMAN, and PAWLING

P R. HEYL, presented an informal communication on the question as to the mass equivalent of energy as related to the medium in which energy is radiated. It was discussed by MESSRS. TUCKERMAN and ADAMS.

H. E. MERWIN, *Secretary.*

THE GEOLOGICAL SOCIETY

429TH MEETING

The 429th meeting was held at the Cosmos Club, April 13, 1927, President BUTTS presiding.

Informal communications. D. F. HEWETT described a fault plane exposed at the foot of Mt. Parnassus in Greece, which, because it appears less weathered than nearby inscriptions at Delphi, suggests movement of one or two feet within the past 2500 years.

Program: Professor DONALD H. MCLAUGHLIN, Harvard University: *Geology and physiography of the Andes in Central Peru.* The region discussed lies to the east of the city of Lima and includes the portion of the Andes between the well-known mining districts of Cerro de Pasco and Huancavelica. A detailed description has been published in the Bulletin of the Geological Society of America (**34**: 591–632. 1924.) and in Informaciones y Memorias de la Sociedad de Ingenieros del Peru (**37**: 69–107. 1925) The papers are based on the work of the geological department of the Cerro de Pasco Copper Corporation.

The dominant rocks of the region are Mesozoic limestones and sandstone. They rest on somewhat metamorphosed Paleozoic sediments, and are unconformably overlain by red shales and sandstones with various conglomerates which are provisionally placed in the Tertiary. Volcanic rocks (mostly pyroclastic) occur as an extensive formation between the Paleozoic sediments and the lowest limestones of the Mesozoic, and a later important accumulation of volcanic rock is found at the top of the geologic column, resting upon Tertiary (?) red beds. All the formations are intruded by numerous stocks and irregular masses of igneous rock, generally porphyritic in texture Diorite, trachyte and quartz monzonite have been observed. The important deposits of copper and silver, for which the region is famous, are genetically related to small stocks of these relatively late intrusives.

The present Andes were formed by the warping uplift of a region of low relief, which was produced by long erosion that followed the last period of intensive deformation, probably in the early Tertiary. The uplift took place in three or more stages, and in certain areas appears to have been accompanied by some faulting. The ancient surface has been almost obliterated by the violent erosion on the steep western side of the range, but can still be seen in large areas situated between the great canyons of the streams of the eastern drainage which dissect the central plateaux Glaciation formerly extended as low as 12,000 feet in favorable places and is responsible for the details of the topography in the summit regions (*Author's abstract.*)

430TH MEETING

The 430th meeting was held at the Cosmos Club, April 27, 1927, President BUTTS presiding.

Program: F. L. HESS: *Notes on Florida phosphate deposits.* The production of phosphate from Florida is about 84 per cent of the entire United States production.

From limited observations near Bartow the phosphate gravel of the Bone Valley formation seems to be rolled pebbles, possibly from the Ocala limestone exposed near Dunellon, although there is a possibility that the pebbles may have come from phosphatic limestone in the lower part of the Alum Bluff formation. The phosphate pebbles are the only gravel found in a large area of Florida, and were apparently laid down in salt water, as shown by the presence of great numbers of dugong bones and shark teeth, but were close to land, as shown by the presence of numerous mastodon bones. It is not probable that the dugong bones were weathered from the underlying limestone because in places a number of ribs are sometimes found close together and apparently in their natural spatial relationships.

The phosphate pebbles are being leached, and apparently amorphous calcium phosphate is being deposited either in an irregular sheet under the richest beds of phosphate pebbles or in the sand along cracks carrying the drainage from the pebble beds. The fluorine content of the land pebbles ranges from about 1½ to 3½ per cent, and is utilized in Denmark and Belgium for the manufacture of sodium-fluo-silicate. The product is shipped to the United States, and a present attempt to have the duty on the material raised may result in the loss to Florida of its foreign phosphate trade.

As the phosphate is very cheap ($3 to $5 a ton) and is the only gravel to be obtained in a large area of Florida, it is used for concrete work and for macadamizing roads. (*Author's abstract.*)

G F LOUGHLIN: *Ore at Deep Levels in the Cripple Creek District, Colorado.* Study of deep mine workings in the southeast quarter of the Cripple Creek volcanic breccia has on the whole verified the conclusions reached by Lindgren and Ransome in 1906 (U. S. Geol. Survey, Prof. Paper 54), but has found that veins of telluride ores identical in mineral composition with those mined at comparatively shallow levels continue along master fissures to more than 3000 feet below the present surface or more than 5000 feet below the original surface of the volcano. The distribution of ore shoots is controlled by fissuring which was developed intermittently in part by local disturbances within the volcanic mass and in part by regional disturbance. A local structural feature of much importance is the small neck of basaltic breccia, along the margins of which the famous Cresson orebody has been mined.

The process of vein formation, though complicated in detail, is regarded for practical purposes as having taken place in three stages. the first characterized mainly by dark purple dense fluorspar accompanied by quartz and relatively coarse grained pyrite; the second by lighter purple fluorspar, quartz, dolomite, celestite, roscoelite, and tellurides; the third by vug linings of coarsely to finely crystalline quartz, fine drusy pyrite, a little fluorspar, and in the Dante mine considerable cinnabar

Of special interest is a low grade pyritic ore formed in a mass of breccia in the Dante and Cresson mines and attributed to a process similar to "mineralization stoping" as recently described by Locke (Econ. Geol. 31: 431). Ore shoots in the vicinity pitch in the direction of this breccia, which is believed to lie above a local source of ore-forming solution. Similar mineralized breccia has been found to the south in the Roosevelt Tunnel and the Ajax Mine.

The main deep vein in the Portland mine follows a fissured phonolite dike along the granite-breccia contact which here trends N. N W. This trend is a local deflection along a contact of generally east-west trend and northward pitch. The productive part of the vein pitches northward parallel to the contact, and for the most part has a simple vein structure; but where the granite-breccia contact turns westward, the vein branches. The main part of it turns with the phonolite dike along a N. N. E. fissure The N. N W. part continues but is of comparatively low grade, but the ground between the two branches is cut by minor parallel N. N. E veins which are productive for short distances. The structure here resembles that of the rich Captain and Hidden Treasure veins described by Lindgren and Ransome

The northward pitch of the main deep Portland Ore shoot is in contrast to the southward pitch of ore shoots in the Bull Hill area to the north. Where the vein fissures of Bull Hill have been followed northward on the deepest levels of the Eagles Mine, they are tight and generally non-productive. Evidence as a whole indicates a downward convergence of productive ground southward from Bull Hill and northward from the Portland mine, towards a local source beneath the Last Dollar and Modoc mines. Future production from such deep ground depends more on cost of mining than on the downward persistence of telluride ore. (*Author's abstract.*)

Parker D. Trask and Kirtley F. Mather: *Stratigraphy of the Lake Ainslie Region, Cape Breton Island, Nova Scotia.* The results presented here are due to joint work by the two authors during the summer of 1925, but the lot of obtaining the majority of the stratigraphic details fell to Mr. Trask, Mr. Mather concentrating his attention on unravelling the complicated structure of the region. The Lake Ainslie Region is located in central western Cape Breton Island, some 40 miles northeast of the Strait of Canso and about 75 miles west of Sydney. The following generalized section, based chiefly on sections made along the several Mabou Rivers, summarizes briefly the stratigraphy of the region. The formations, to which local names have been given, are for the most part continental in origin and vary considerably in thickness from the figures given. The formations described in the pioneer work of Fletcher (Can. Geol. Surv. Ann. Repts. 1875–1877 and later years) are subdivided, and although not personally compared, analogies between the formations of the Lake Ainslie Region and those of the Sydney Region, described by J. E. Hyde (Can. Geol. Surv. Summ. Rept. 1912: 392) and Hayes and Bell (Can. Geol. Surv. Mem. 133. 1923), are pointed out.

GENERALIZED SECTION OF FORMATIONS IN THE LAKE AINSLIE REGION, CAPE BRETON ISLAND, NOVA SCOTIA

	Thickness in feet
Pennsylvanian.	
Port Hood coal-measures:	
Highly cross-bedded sandstones and shales with intercalated coal seams Thickness not measured . . .	(?)
Important unconformity (Port Hood measures rest on all formations from Super-Mabou to the Judique series.)	
Pennsylvanian (?) (In part perhaps equivalent to the Pt. Edward formation of the Sydney Region, which according to Hyde is Pennsylvanian.)	
Super-Mabou beds:	
Sandstones and shales, predominantly red in color .	1500
Mabou formation.	
Chiefly gray shales, almost fissile. Numerous intercalated gray sandstones containing plant fragments. Some reddish zones and one zone, 15 feet thick and 500 feet above base of formation, of alternating laminae of gypsum and gray shale . .	1500
MacFarlane red beds	
Red sandstones and shales. Some cross-bedding, but mostly fairly well stratified	1000
Middle Bridge formation.	
Chiefly dark gray thin-bedded shales, containing numerous creamy white thin limestone layers, some of which weather in a peculiar mammillary fashion . . .	250
Total Pennsylvanian (?)	4250
Unconformity	
Mississippian:	
Judique series (In part at least of Windsor age. Comparable to the Windsor series of Hyde at Sydney. Core drilling recently conducted by Mr. K. C. Heald indicate that the Judique series is thicker and contains considerably more gypsum and limestone than given here.)	
Red sandstone and shale. Gypsum near base	500
Black oolitic limestone, in places characterised by an abundance of *Nucula?*	5–15
Red sandstone and shale .	300–600
Yellow impure limestone and limestone breccia, which weathers in a peculiar honeycomb pattern. Fossiliferous in places . .	25–40
Red sandstone and shale. Some gypsum .	100–200
Finely laminated gray shale	30
Bentonite and gray tuff. Found on Baddeck River . .	0–1
Finely laminated massive gray limestone. Very persistent and easily recognized by its peculiar ribbon-like structure	30
Red sandstone and shale	150
Total Mississippian	1550

Mississippian (?):	
Dunbar series. (Comparable to middle division of Hyde's Mississippian at Sydney.):	
Ainslie sandstone:	
Fine to medium-grained cross-bedded sandstone	700
Gray and greenish sandstone and shale zones, the sandstones several hundred feet thick and the shales less than 100 feet	1500
Chocolate and dark red cross-bedded sandstones and shales	1200
Total Dunbar series	3400
Kewstoke conglomerate (Comparable to the "Carboniferous conglomerate" series of Fletcher and Hyde):	
Chiefly massive coarse-grained arkosic sandstones and conglomerates which become progressively more fine-grained toward the top. Pinkish in some zones Layers of impure coal 1000 feet from the top of the formation on S E Mabou River	150–3000
Total Kewstoke conglomerate	3000
Pre—Carboniferous:	
Marbles, quartzites, gneisses, granites, volcanics, and chlorite schists	(?)

The yellow fossiliferous, cavernous limestone occurring in the middle of the Judique series at Middle River yielded the following fossils, which have been identified by Professor P. E. Raymond, of Harvard University, and are thought by him to be more closely allied with the Windsor fauna of the Magdalen Islands than with that of the Windsor District of Nova Scotia and to be of Middle or Upper Mississippian age: *Productus tenuicostiformis* Beede (common), *P. dawsoni* Beede, *Dielasma* cf. *D. sacculus* (Martin) (common), *Composita dawsoni* (Hall and Clarke) (rare), *Aviculopecten* sp., *Parallelodon dawsoni* Beede (rare). A very similar fauna was found by Hayes (Can. Geol. Surv. Summ. Rept. 1917 (F): 21) in a brown cavernous limestone near Sydney. (*Author's abstract.*)

W. P. WOODRING, W. W. RUBEY, *Secretaries.*

SCIENTIFIC NOTES AND NEWS

NEIL M. JUDD, Curator of American Archeology, United States National Museum, left Washington May 28th to complete his explorations at Pueblo Bonito, New Mexico, under the auspices of the National Geographic Society. This season's expedition is the seventh sent by the Society for the purpose of recovering and recording the story of this prehistoric Indian village.

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OCEANOGRAPHY—*Current harmonic constants for San Bernardino Strait, P. I.*

L. P. Disney, U. S. Coast and Geodetic Survey. (Communicated by H. A. Marmer.)[1]

Although harmonic analyses of the tide have been made for numerous places in the Philippine Islands it was not until 1926 that a comprehensive series of current observations in San Bernardino Strait furnished sufficient data for deriving the first harmonic constants for the currents in any of the waterways of the archipelago.

These observations were obtained between May 15 and June 14, 1926, by Lieutenant F. S. Borden from the Coast and Geodetic Survey Steamer FATHOMER. The station was located midway between Calayuan and Totoog Points in fifty-five fathoms of water. Observations were made every half hour throughout the series with standard 15 foot current pole so weighted on the end as to float with but one foot out of water. For the greater depths, 20, 50, and 80 feet, Gurley current meters were used. The directions of the current were obtained both by pelorus and compass methods and by angles on distant triangulation stations.

A harmonic analysis of these observations covering a 29 day series beginning May 15, 1926, has recently been made by the Coast and Geodetic Survey. The analysis is based upon the hourly velocities of the current as obtained from both meter (20 foot depth) and pole observations and consequently represents an average depth of 13½ feet.

The results derived from the analysis are given in Table 1. The current amplitudes are expressed in knots, and the epochs, as customary, are referred to the local meridian. The more important components were derived from a direct analysis and cleared for the effects of

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[1] Received May 21, 1927.

other components. The secondary components were derived by inference from the principal components. These inferred values are enclosed in parentheses.

TABLE 1 —CURRENT HARMONIC CONSTANTS, SAN BERNARDINO STRAIT, P. I.

COMPONENT	H	κ	COMPONENT	H	κ
	knots	*degrees*		*knots*	*degrees*
J_1	(0 100)	(242)	OO	(0 055)	(262)
K_1	1 776	223	P_1	(0 588)	(223)
K_2	(0 386)	(257)	Q_1	(0 268)	(165)
L_2	(0 086)	(246)	$2Q$	(0 036)	(145)
M_1	(0 114)	(203)	R_2	(0 012)	(257)
M_2	3 047	232	S_2	1 418	257
M_4	0 143	328	S_4	0 052	281
M_6	0 044	338	T_2	(0 084)	(257)
M_8	0 032	108	λ_2	(0 021)	(243)
N_2	0 360	217	μ_2	(0 073)	(206)
$2N$	(0 048)	(203)	ν_2	(0 070)	(219)
O_1	1 382	184	ρ_1	(0 052)	(167)

Through the use of these constants the currents in San Bernardino Strait can now be readily predicted on the tide predicting machine in a manner analogous to that used in the prediction of tides.

The constants furthermore furnish a ready means of determining the characteristics of the current in San Bernardino Strait, the principal constants alone being sufficient for an approximate determination. Thus, approximately, it is seen that the average maximum velocity of the current is about 3 knots, while the strength of current at the times of spring and neap tides is about 4½ and 1½ knots, respectively. The ages as derived from the constants are: phase age 24.6 hours, parallax age 27.6 hours, and diurnal age 35.5 hours. The type of current is determined to be of the mixed type, the ratio of $K_1 + O_1$ to M_2 being 1.04.

With regard to the type of current, the observations bring to light the existence of a nontidal current in San Bernardino Strait which materially affects the tidal current in the Strait, especially near the times of the moon's maximum north and south declinations. On such days the large diurnal inequality in conjunction with the southwesterly nontidal current causes the current to flood for the greater part of the day with varying velocity. This results in one ebb and a flood with two maximum velocities and an intervening minimum velocity.

A reduction of the observations shows an average maximum flood velocity of about 4.6 knots and an average maximum ebb velocity of about 3.7 knots. The average strength of the minimum flood was found to be about 1.3 knots. Considering the minimum flood as a negative ebb the average velocity of the maximum ebb would be about 2.2 knots. This indicates that during the period of observations the southwesterly nontidal current was flowing with a velocity of about 1.2 knots, which agrees with the velocity as determined directly from the stencil sums for components.

BOTANY.—*New species of* Cordia *and* Tournefortia *from northwestern South America.*[1]

ELLSWORTH P. KILLIP, U. S. National Museum.

A revision of the Andean species of two genera of Boraginaceae, *Cordia* and *Tournefortia*, has been prepared by the writer. Publication of this is being postponed in order to include in the treatment the results of study of numerous specimens of these genera collected by the recent Killip-Smith expedition to eastern Colombia. The new species so far noted in preparing this revision, ten of *Cordia* and seven of *Tournefortia*, are here published in advance.

Cordia crassifolia Killip, sp nov.

Tree (?); branchlets terete, densely short-rufo-hirsutulous or tomentose; petioles about 1 cm. long, stout; leaves oblong-obovate, 10 to 15 cm. long, 4 to 7 cm wide, obtuse or acutish at apex, gradually narrowed to a rounded base, entire, conspicuously nerved (lateral nerves 7 or 8 pairs), reticulate-veined, thick-coriaceous, lustrous and scabrid with short subappressed white hairs above, rufo-hirtellous and smooth beneath; inflorescence much shorter than the leaves (5 cm. long in type though evidently not fully developed), subdichotomous, the branches and calyces densely subappressed-ferruginous-hirsute, the flowers sessile, borne in clusters of 4 to 6 at ends of branches of inflorescence; calyx cylindric, 3 to 4 mm. long, indistinctly ribbed, the teeth minute; corolla lobes obtuse; anthers linear-oblong.

Type in the U. S. National Herbarium, no. 940117, collected in Colombia or Ecuador, by F C. Lehmann (no. 6611).

The corolla is not sufficiently developed for the positive determination of the position of this species, but the small, indistinctly ribbed calyx suggests a relationship with *C. opaca* and *C sulcata*, rather than with *C. alliodora* or *C. alba*.

Cordia colombiana Killip, sp. nov.

Tree; branchlets terete, dark chestnut-brown, glabrous or very sparingly pilosulous toward ends; petioles stout, about 1 cm long, slightly sulcate, glabrous; leaves ovate or ovate-oblong, 10 to 18 cm. long, 4 to 8 cm. wide, abruptly acuminate at apex (acumen about 2 cm long), rounded or subcuneate at base, entire, conspicuously nerved and veined (principal lateral

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[1] Published by permission of the Secretary of the Smithsonian Institution Received June 6, 1927.

nerves 4 or 5 to a side), coriaceous or subcoriaceous, lustrous, glabrous or minutely hispidulous; inflorescence terminal, cymose, the cymes subdichotomous, up to 4 cm. wide, the branches ferruginous-hirsutulous, the peduncles short; calyx cylindric-obovoid in bud, broadest at apex, at length cylindric-turbinate, 4 to 5 mm. long, densely ferruginous-tomentose, the lobes deltoid, 1 to 1.5 mm. long, corolla white, funnel-shaped, 6 to 8 mm. long, about 3 mm. wide at throat, glabrous, the lobes orbicular, 2 mm. wide; stamens exserted; styles filiform, exserted, the divided portion equaling the united portion.

Type in the U. S. National Herbarium, no. 1,140,963, collected in thicket, between San Antonio and Río Ortega, Department El Cauca, Colombia, altitude 2100 to 2300 meters, July 2, 1922, by F. W. Pennell and E. P. Killip (no. 8024).

The foliage of this species is very similar to that of *C. bogotensis*, a plant with flowers fully three times as large, and differing in other details.

Cordia allartii Killip, sp. nov.

Tree(?); branchlets terete, glabrous; leaves oblong or oblong-lanceolate, 15 to 25 cm. long, 8 to 12 cm. wide, attenuate-acuminate at apex, rounded at base, entire, conspicuously nerved and veined (principal lateral nerves 5 or 6 pairs, distant, arcuate-ascending), coriaceous, lustrous on both surfaces, glabrous, occasionally minutely hispidulous on nerves beneath; inflorescence cymose, about 4 cm. long, the branches and calyces densely ferruginous-tomentose, the flowers sessile, in clusters of 3 or 4; calyx obovoid in bud, at length cylindric-campanulate, 4 to 4.5 mm. long, 3 to 4 mm. wide at throat, the lobes ovate-deltoid, 2 mm. long, acute; corolla tube as long as calyx, the lobes orbicular-ovate, 2 5 to 3 mm. long, rounded, reflexed; stamens not exserted, the anthers oblong, 1 mm. long; ovary lance-ovoid.

Type in the U. S. National Herbarium, no. 1,230,256, collected at Colonia Tovar, Venezuela, altitude 1800 to 2000 meters, December, 1924, by A. Allart (no. 352).

Related to *C. colombiana* but with broadly campanulate calyx and much broader corolla lobes.

Cordia macrodonta Killip, sp. nov.

Tree or shrub; branchlets quadrangular, ferruginous-puberulent and finely pilosulous, scabrous; petioles 0.5 to 1 cm. long; leaves broadly ovate, 6 to 11 cm. long, 4 to 6.5 cm. wide, abruptly short-acuminate at apex, narrowed to petiole, coarsely and sharply serrate-dentate except in lower third, penninerved (principal nerves 6 or 7 to a side, the secondary nerves prominent), membranous, short-strigillose-hispid above (hairs swollen at base), finely pilosulous beneath; inflorescence paniculate-cymose, the peduncles about 4 cm. long, the flowers borne singly near the ends of the branches; calyx globose-turbinate, about 2 mm. long, appressed-ferruginous-strigillose, the teeth triangular, acute, 0 5 mm. long; corolla tube cylindric, about 3.5 mm. long, the lobes orbicular; stamens attached at throat of tube, scarcely 1 mm. long, the anthers oblong, less than 0.5 mm. long; fruit ovoid-conic, 5 mm. long, 4 mm. wide, glabrous

Type in the Field Museum of Natural History, no. 548642, collected at San Antonio, Province Huancabamba, Dept. Puira, Peru, altitude 1200–1300 meters, March, 1912, by A. Weberbauer (no. 6015).

Belonging to DeCandolle's section *Corymbosae* this species is at once distinguished from other representatives of the section by the coarsely serrate leaves.

Cordia coriacea Killip, sp. nov.

Tree (?); branchlets subangular, sulcate, finely canescent-puberulent; petioles 5 to 10 mm. long, canaliculate, sulcate; leaves ovate-elliptic or ovate-oblong, 10 to 15 cm. long, 5 to 7 cm. wide, attenuate-acuminate at apex, cuneate and often oblique at base, entire, penninerved (midnerve strongly sulcate, the lateral nerves 6 or 7 to a side, ascending, arcuate toward ends), inconspicuously closely reticulate-veined, coriaceous, above sublustrous, glabrescent, minutely tomentellous on nerves, beneath brownish-puberulent on nerves and veins, elsewhere softly grayish-tomentose; peduncles about 5 cm. long; inflorescence about 4 times dichotomous, cano-puberulent, the flowers sessile, in clusters of 3 or 4 at ends of the divaricate branches of the inflorescence, calyx turbinate, 4 to 4.5 mm. long, 2 5 to 3 mm. wide, slightly sulcate, cano-puberulent, the lobes lanceolate, 1 mm. long, acute, erect; corolla lobes linear-oblong, 2 mm long, 1 mm wide, obtuse, stamens exserted, the anthers linear, 1 mm. long; ovary depressed-globose, style 3 mm. long, exserted.

Type in the U. S National Herbarium, no. 1,133,957, collected at Charopampa, near Mapiri, Bolivia, altitude 570 meters, November, 1907, by O. Buchtien (no. 2040).

The sulcate calyx places this species near *C. opaca* and *C. crassifolia*. The calyx, however, is turbinate rather than cylindric, and the shape of the leaves and nature of the indument are quite different than in either of these.

Cordia venosa Killip, sp. nov

Tree; branchlets terete (younger portions subangular and sulcate), densely rufo-tomentose; petioles 1 to 2 cm long; leaves ovate or ovate-oblong, 10 to 20 cm. long, 7 to 8 cm wide, acute or attenuate-acuminate at apex, rounded at base, entire, strongly nerved and veined (principal lateral nerves 6 to a side, arcuate-ascending), reticulate-veined, subcoriaceous, above dark green (almost black when dry), rufo-tomentose on principal nerves, finely hirsutulous on secondary nerves and veins, the indument beneath similar but much denser; inflorescence cymose, the branches dichotomous, densely rufo-tomentose, the peduncles about 6 cm. long; calyx broadly ovoid in bud, at length cylindric-campanulate, 4 to 5 mm. long, about 3 mm. wide, rufo-tomentose, the lobes deltoid, 1.5 to 2 mm. long, acute; corolla pale greenish white, pilosulous at throat within, the lobes oblong-spatulate, 4 mm long, 2.5 mm. wide, rounded or truncate at apex, dark-veined; stamens scarcely exserted, 2 mm. long, the anthers ovate-oblong, 2 mm long, ovary conical, longer than style.

Type in the U. S. National Herbarium, no. 1,140,957, collected at San José, above San Antonio, Department El Cauca, Colombia, altitude 2300 to 2500 meters, July 1, 1922, by F. W. Pennell (no 7657).

In the shape and texture of the leaves this species closely resembles *C. bogotensis* and *C. colombiana*. From both it is readily distinguished by the dense indument on the branchlets and the under surface of the leaves. The flowers are much smaller than those of *C. bogotensis*, and the shape of the calyx and corolla lobes is different from those in *C. colombiana*.

Cordia mollissima Killip, sp. nov.

Shrub, thickly and softly lanate-tomentose throughout; branches terete; petiole up to 1 cm long; leaves ovate-lanceolate, up to 7 cm. long, 3.5 cm. wide, acute or acuminate at apex, rounded or acutish at base, serrulate except at base, penninerved (primary nerves about 8 to a side), reticulate-veined (nerves and veins deeply impressed above), dark green above (mid-nerve paler), paler beneath (veins darker); inflorescence contracted supra-axillary few-flowered cymes, before anthesis nearly globose heads, the branches becoming evident after anthesis; calyx campanulate, about 2 mm. wide, lobed one-third to one-half the length, the lobes deltoid, acute; corolla cylindric, 3 to 3.5 mm. long, shallowly lobed; stamens and style about 1.5 mm long; anthers ovate-oblong, 0 5 mm. long, scarcely exserted.

Type in the herbarium of the Field Museum of Natural History, no. 548725, collected near Taen, Province Taen, Department Cajamarca, Peru, altitude 1200 to 1300 meters, April, 1912, by A. Weberbauer (no. 6202). Duplicate in Berlin herbarium.

PERU: Chachapoyas, *Mathews* 3134 (K).[1]

Related to *C. corymbosa* but differing in the dense white indument and in the closely serrulate leaves.

Cordia krauseana Killip, nom. nov.

Cordia pauciflora Krause, Bot. Jahrb. Engler 37: 629. 1906, not *Cordia pauciflora* Rusby, 1896.

Cordia asterothrix Killip, sp. nov.

Shrub 1 5 to 2 meters high, much-branched, the branches smooth or slightly scabrid, more scabrid and cano-stellate-tomentose toward tips; petioles 5 to 8 mm long; leaves ovate or ovate-lanceolate, 2.5 to 5 cm. long, 1 to 3 cm. wide, obtuse or acutish at apex, rounded at base, abruptly cuneate to petiole, irregularly crenate-serrate, densely stellate-hispidulous above, also tomentose when young, cano-stellate-tomentose beneath; peduncles up to 6 cm long, cano-stellate-tomentose; heads 1 5 to 2 5 cm in diameter, densely flowered; calyx campanulate, 5 to 7 mm long, densely cano-stellate-lanate, the teeth filiform, 2 5 to 3 5 mm. long, corolla white, the tube subequal to calyx, glabrous, the limb rotate, 7 to 10 mm. wide; anthers exserted, ovate-oblong, about 1 mm long

Type in the U S. National Herbarium, no. 1,043,330, collected along Río Limón, Venezuela, May 10, 1917, by H. M. Curran and M. Haman (no. 808).

COLOMBIA: Department Huila, Quebrada de Angeles to Río Cabrera, 450–500 meters, *Rusby & Pennell* 333 (N, Y)

This differs from *C. macrocephala* in not having the corolla tube exserted beyond the calyx, and in the white, rather than rust-colored, indument of the calyx.

Cordia rosei Killip, sp. nov.

Small tree or shrub, 4 to 5 meters high, much branched, the branchlets terete, dark brown, glabrous, the younger parts ferruginous-short-hirsute;

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[1] The various herbaria at which specimens have been seen by the writer are thus indicated F, Field Museum of Natural History, K, Royal Botanic Gardens, Kew, N, U S. National Herbarium, Y, New York Botanical Garden.

petioles 1 to 2 cm. long, straight or slightly geniculate near base, leaves ovate-lanceolate or oblong-lanceolate, up to 9 cm long, 5 cm. wide, acute or acuminate at apex, usually tapering at base to petiole, crenate-serrate, entire at base, penninerved (primary nerves 5 to 7 to a side, furcate toward margin), reticulate-veined, above rugulose, scabrous and sparingly hispidulous, beneath lanate, densely subappressed-pilose on the nerves and veins with glistening whitish hairs; inflorescence spicate, the spikes terminal on the branches or on short branchlets, not branched, cylindric, 3 to 6 cm long (peduncle usually shorter than spike), up to 1.5 cm. thick, very densely flowered, ferruginous-tomentose throughout; calyx campanulate, about 3 mm. wide at throat, 5-lobed about a third its length, the lobes ovate-deltoid, acute; corolla cylindric-campanulate, 4 to 5 mm long, about 4 mm. wide at throat, shallowly lobed, glabrous; stamens 2 mm. long, the anthers ovate, slightly exserted; style about 2 mm long, cleft about half its length.

Type in the U. S. National Herbarium, no 1,021,916, collected at Hacienda de Licay, vicinity of Huigra, Province of Chimborazo, Ecuador, August 20, 1918, by J. N Rose and G Rose (no. 22247)

ECUADOR: Province Chimborazo, Huigra, *Rose & Rose* 23860 (N); *Hitchcock* 20387 (N). Province Tungurahua, Ambato, *Pachano* 219 (N).

Allied to the Peruvian *C. subserrata*, this proposed species differs in having very compactly flowered spikes and smaller corollas.

Cordia micayensis Killip, sp nov.

Shrub; branchlets terete below, angular toward tip, ferruginous-hirsutulous; petioles 1 to 2 cm. long, ferruginous-hirsutulous; leaves broadly ovate or ovate-lanceolate, 10 to 13 cm long, 5 to 7 cm wide, acuminate at apex, cuneate at base, closely serrate, entire at base, reticulate-veined (principal nerves 7 to 9 on a side, approximate at base and apex, rather distant at middle, the veins impressed on upper surface), above hispidulous and scabrellous, hirsutulous on the nerves, beneath appressed-pubescent on the nerves, elsewhere glabrous, inflorescence spicate, the spikes terminal and lateral, the peduncles and rachises 14 to 17 cm. long, densely ferruginous-hirsutulous; calyx tubular-campanulate, 4 to 6 mm long, 3 mm wide, hirsutulous, the teeth ovate-lanceolate, about 2 mm. long, apiculate; corolla tubular-campanulate, 7 to 8 mm. long, 3 to 3 5 mm. wide at throat, white, glabrous without, tomentose at throat within, 5-lobed, the lobes about 1.5 mm. long, rounded; stamens included, styles 2 mm. long, included, fruit ovoid, 5 mm long, acutish.

Type in the U. S. National Herbarium, no 1,140,959, collected in forest at La Gallera, Micay Valley, Department El Cauca, Colombia, 1800 meters, July 1, 1922, by E. P Killip (no. 7920).

The main characters by which this species can be distinguished from *C. cylindrostachya*, its nearest relative, are more ovate leaves, larger calyx with longer teeth, prominent corolla lobes, and much shorter style.

Tournefortia chinchensis Killip, sp nov.

Liana (or shrub, 2 meters high?); branches terete (or the ultimate subangular), scurfy, ferruginous-hirsutulous; petioles 0 5 to 1 cm. long, leaves opposite, ovate-oblong to narrowly oblong, 3 to 7 cm long, 0.8 to 3 cm wide, acute, slightly narrowed at base, entire, penniveined (nerves impressed above, elevated and prominent beneath, the principal lateral ones 6 or 7 to a side), subcoriaceous, glabrous or sparingly hispidulous above, glabrous beneath except for the ferruginous-hirsutulous nerves and veins; inflorescence 3 or 4-dichotomous, the ultimate branches 2 to 3 cm. long in flower, the flowers about 2 mm apart; sepals linear, 2 to 3 mm. long, about 1 mm. wide, acute, glabrous or sparingly pilosulous without; corolla tube cylindric, 6 to 9 mm. long, 1 to 1.5 mm. in diameter, slightly enlarged near middle, ferruginous-tomentose, greenish, the lobes orbicular, minute, scarcely 1 mm long, glabrous; white; stamens attached near throat of tube, 1 to 1.5 mm. long; style 5 mm long, clavate; fruit depressed-subglobose, about 8 mm. in diameter, white, glabrescent.

Type in the herbarium of the Field Museum of Natural History, no 536185, collected at Villacabamba, Río Chinchao, Department Huánuco, Peru, altitude about 2000 meters, July 17–26, 1923, by J. F. Macbride (no. 5142). Duplicate in U. S. National Herbarium *Weberbauer* 6607, from southwest Comas, Province Jaiya, Department Junín, altitude 3300–3400 meters, is also this species; the leaves are proportionately narrower than in the type. This locality is considerably farther south than that at which the type was collected.

The differences between this species and its two nearest relatives, all characterized by minute corolla lobes, may be shown by the following key:

Flowers sessile; corolla tube appressed-hirsute; branchlets smooth. T. ANDINA.
Flowers pedicellate, corolla tube tomentose, branchlets rough.
  Calyx lobes 2 mm. long or less; leaves alternate T. OVALIFOLIA.
  Calyx lobes more than 2 mm. long; leaves subopposite. T. CHINCHENSIS.

Tournefortia setacea Killip, sp. nov.

Liana; stems subquadrangular, appressed-strigillose, with short white hairs, the older portions glabrate; petioles 0.5 to 2 cm. long, leaves subopposite or in three's, oblanceolate or ovate, 5 to 14 cm. long, 3 to 7.5 cm. wide, abruptly acuminate, narrowed at base, subdecurrent, entire, penninerved (lateral nerves 5 to 8 to a side), membranous, above dark green, appressed-short-strigillose and minutely whitish-punctate, beneath paler, appressed-strigillose on the nerves, otherwise nearly glabrous, inflorescence terminal and lateral, 7 cm. wide or less, few-branched, short-peduncled, flowers sessile; sepals linear-setaceous, 4 to 5 mm. long, 0.5 mm. wide or less, appressed-strigillose, green; corolla tube cylindric, 4 to 5 mm. long, about 1 mm. in diameter, appressed-strigillose and white-punctate without, the lobes ovate-orbicular, about 1 5 mm. long, minutely mucronulate, cream-colored; stamens attached near base of corolla tube, the anthers narrowly linear, about 2.5 mm. long; fruit conical, 3 to 4 mm long, appressed-strigillose, white.

Type in the Field Museum of Natural History, no. 536620, collected at La Merced, Department Junín, Peru, altitude about 600 meters, August 10–14, 1923, by J. F Macbride (no. 5579; duplicate in U. S. National Herbarium).

PERU: Department Huánuco, Cushi, 1800 meters, *Macbride* 4829 (N, F).

BOLIVIA: Bopi River, *Mulford Biological Exploration* 481 (N, Y).

This resembles *T. bicolor* Sw., a common plant of the American tropics. The long setaceous sepals, like those of *T. umbellata*, of Mexico, at once distinguish it.

Tournefortia auro-argentea Killip, sp. nov.

Shrub or small tree; branches subquadrangulate, hirsutulous-tomentose, at length glabrate; petioles 2 to 3 cm long; leaves opposite, ovate, 8 to 17 cm. long, 5 to 8 cm. wide, acute or acuminate at apex, tapering at base, entire or subundulate at margin, conspicuously nerved (nerves ascending, subopposite, 7 or 8 pairs), subcoriaceous, rugulose, above sparsely hispidulous, tomentellous on midnerve, beneath minutely hirsutulous-tomentellous on nerves and veins; inflorescence 2 or 3-dichotomously branched, the branches hirsutulous-tomentose, the flowering portions up to 7 cm. long; sepals lanceolate, 4 to 5 mm. long, 1.5 mm. wide, acuminate, hispidulous with silvery-white hairs; corolla white (?), the tube 6 to 7 mm long, golden-brown-hirsute, the lobes ovate, 2 mm. wide, mucronate; fruit globose, 6 to 7 mm. in diameter.

Type in the U. S. National Herbarium, no. 703566, collected on the road from Torondoy to Mucuchías, Cordillera de Mérida, State of Mérida, Venezuela, altitude 3000 meters, March 27, 1915, by Alfredo Jahn (no. 396).

Tournefortia vestita Killip, sp. nov.

Shrub, about 1.5 meters high; branchlets sulcate, stout, 5 to 7 mm. thick even toward end, densely hirsute with subreflexed brown hairs up to 4 mm. long; petioles stout, up to 2 5 cm. long, with indument like that of stem; leaves ovate-oblong or ovate-lanceolate, 15 to 25 cm. long, 5 to 14 cm wide, acute to abruptly short-acuminate, acute and subdecurrent at base, entire or minutely serrulate, penninerved (lateral nerves 9 to 11 to a side), densely appressed-hirsute above with hyaline hairs, densely hirsute or hirsute-tomentose beneath with matted hyaline hairs; inflorescence terminal and lateral, the peduncles 5 to 7 cm. long, stout, hirsute, the branches 2 or 3 times dichotomous, the flowering portions up to 12 cm. long; flowers sessile; calyx lobed nearly to base, the lobes linear-attenuate, 5 to 7 mm. long, hirsute; corolla greenish white, the tube cylindric, 8 to 10 mm long, 1.5 to 2 mm. wide, hirsute with subappressed reflexed hairs, the lobes orbicular, about 2 mm. wide, rounded at apex; fruit globose-ovoid, 5 to 6 mm. in diameter, glabrous.

Type in the U. S. National Herbarium, no. 32812, collected in clay and mud soil, Coroico, Department La Paz, Bolivia, September, 1894, by M. Bang (no. 2470). A duplicate is in the herbarium of the New York Botanical Garden.

BOLIVIA: Department La Paz, Mapiri, 1800 meters, *Rusby* 1922 (Y).

The differences between *T. vestita* and *T. obscura*, another species with hispid-hirsute branches and narrow calyx lobes are: *T. vestita*, corolla tube 1.5 mm. wide or more, inflorescence two or three times dichotomous, with equal branches, leaves more than 15 cm. long, the pubescence hyaline above, densely matted beneath; *T. obscura*, corolla tube less than 1.5 mm. wide, inflorescences a repeatedly dichotomous cyme, the branches very unequal, leaves usually much less than 15 cm. long, the pubescence of slender straight hairs.

Tournefortia obovata Killip, sp. nov.

Small tree; branches quadrangulate, hirsute, at length glabrous; petioles 1.5 to 2 cm. long, ferrugineous-hirsute-tomentose; leaves obovate, 9 to 16 cm. long, 4 to 7 cm. wide, rounded or acutish at apex, tapering gradually at base, (nerves subopposite, 12 to 15 pairs, divaricate), above bullate, hispid, beneath ferruginous hirsute-tomentose; inflorescence 3 to 4-dichotomous-branched, the branches hirsute, the flowering portions up to 5 cm. long; calyx-lobes ovate-lanceolate, 1.5 to 2 mm. long, hirsute; corolla "greenish," the tube 3 mm. long, 2 mm. wide, cano-hirsute, the lobes orbicular, obtuse; fruit globose, glabrous.

Type in the U S National Herbarium, no. 530946, collected at Cali, Department El Valle, Colombia, altitude 1000 to 1200 meters; December, 1905, by H. Pittier (no. 755)

From *T. fuliginosa*, to which it is related, this species is distinguished by obovate, less acute leaves, shorter and more slender spikes, smaller calyx and shorter corolla-tube.

Tournefortia buchtienii Killip, sp. nov.

Shrub, about 4 meters high; branches subterete, ferruginous-tomentose, rough, petioles up to 2 cm. long; leaves opposite, oblong or oblong-elliptic, 7 to 14 cm. long, 3 to 5 cm wide, acuminate, rounded or acutish at base, entire, penninerved (nerves slightly impressed above and elevated beneath, the primary ones about 10 to a side, the transverse secondary nerves rather conspicuous, nearly parallel), reticulate-veined, membranous, above dark green, appressed-strigillose except along nerves, beneath ferruginous-hirsutulous, especially along nerves; peduncles 6 to 7 cm. long, ferruginous-tomentose, subternately-branched, the branchlets 2 or 3 times dichotomous, the flowers borne on the ultimate branches at nearly uniform intervals of 2.5 mm ; sepals linear, 2 to 3 mm long, acute, ferruginous-hirsutulous; corolla tube narrowly cylindric, 7 to 10 mm long, 1 5 to 2 mm. wide, dilated just below throat, ferruginous-tomentose without, the lobes orbicular, minute, 0 5 to 1 mm wide; stamens attached near throat of tube, linear, 2 mm long; style thick, about 7 mm. long; fruit ovoid-conical, about 7 to 8 mm. long, 5 to 8 mm in diameter, glabrescent, white.

Type in the U. S. National Herbarium, no 1,133,948, collected at Unduavi, South Yungas, Bolivia, altitude 3200 meters, February 12, 1907, by O. Buchtien (no. 2949) A duplicate of this is in the herbarium of the New York Botanical Garden.

BOLIVIA: Unduavi, *Rusby* 1923 (Y).

Tournefortia rollotii Killip, sp. nov.

Low shrub; branches subquadrangulate, stout, the older glabrescent, the younger densely grayish-hirsute; petioles 2 to 4 cm. long, canaliculate above, hirsute; leaves broadly ovate, 8 to 15 cm. long, 5 to 10 cm. wide, acute at apex, rounded at base, abruptly tapering to petiole, slightly undulate at margin, conspicuously nerved (nerves ascending, subopposite, about 8 pairs), reticulate-veined, above pilosulous, beneath densely tomentose with fine hairs; cymes 3-dichotomous, the peduncles and branches ascending, densely hirsute; calyx lobes narrowly lanceolate, 3 to 4 mm. long, hirsute; corolla white, the tube 5 mm. long, hirsute-tomentose, the lobes ovate or ovate-lanceolate, 3 to 3 5 mm. long, 1 mm. broad at base, long-cuspidate, the cusp 2 to 2.5 mm long; fruit ovoid-globose, 7 to 8 mm. long, 5 to 6 mm. in diameter.

Type in the U. S. National Herbarium, no. 1,059,749, collected on the Páramo de Guasca, Department Cundinamarca, Colombia, by M. Rollot (Ariste-Joseph no. A492).

COLOMBIA: Department Cundinamarca, Zipaquirá, *Pennell* 2565 (Y).

The unlobed fruit of *T. rollotii* and its erect habit indicate a relationship with the species placed by DeCandolle in the first section of *Pittonia*, rather than with the more or less scandent plants, with lobed fruits, of the second section. The corolla lobes, relatively broad but terminating in a distinct cusp, suggest *T. peruviana* and *T. mapirensis*, of the latter section.

BOTANY.—*Some Rubiaceae collected in Mexico in 1841–43 by Frederik M. Liebmann.* PAUL C. STANDLEY, U. S. National Museum.[1]

The U. S. National Museum received recently for study, from the University Botanical Museum of Copenhagen, through the kindness of Dr. Carl Christensen, a large series of plants of the family Rubiaceae, collected in southern Mexico in 1841–43 by Frederik Michael Liebmann. The material included most of the plants of this group obtained by Liebmann, the greater part of which had never been identified. Many of them had been submitted to Hooker, and some of the duplicates retained at Kew were listed by Hemsley in the Botany of the Biologia Centrali-Americana. Although many of the specimens which passed through Hooker's hands were named specifically, others were identified only to the genus. Some of the latter were studied also by Oersted, in connection with his work upon Central American Rubiaceae, and a few were indicated by him as new, but he never published descriptions of them.

Determination of this collection has given interesting results. Liebmann was an exceptionally efficient collector, with a keen eye for distinguishing species, and he found a number of well-marked Mexican Rubiaceae which have eluded later collectors. His whole series of plants was one of the largest ever obtained in Mexico, consisting of 90,000 specimens. He was not content with one specimen of each plant that he recognized, but repeated his collections. Too many of his successors have been satisfied to make a single collection of each species that they were able to distinguish in the field, and as a consequence they have overlooked the critical species which require a nice discrimination for their recognition. Doubtless a part of Liebmann's success resulted from the fact that he visited regions which have not received attention from more recent collectors. It is a noteworthy fact that the earlier botanists working in Mexico were able to visit remote regions, while those of recent decades seem not to have wandered far from the principal railway lines.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 13, 1927.

Study of the Liebmann material has disclosed several species which are apparently new, and one plant which can not be referred satisfactorily to any known genus. It is unfortunate that these rich collections did not receive thorough study immediately upon their arrival in Europe, eighty years ago, for they include many species which have been based upon material procured by later collectors, some of them, indeed, of very recent date.

There are described below the new species recognized in the *reliquiae Liebmannianae*, and there are cited also some of the numbers which illustrate rare or little-known species. Upon the basis of the Liebmann plants there may be reported from Mexico for the first time several common American Rubiaceae of wide distribution. The species here listed form a noteworthy addition to the woody Rubiaceae enumerated in the Trees and Shrubs of Mexico.[3]

Most of the Liebmann material was received on loan, and has now been returned to Copenhagen, after photographs had been made of some of the more important specimens. There were received also numerous duplicates for deposit in the National Herbarium. In the citation of specimens in the following pages, the letter "C" indicates that the number cited is represented only in the Copenhagen herbarium.

RONDELETIA HETERANTHERA T. S. Brandeg. Univ. Calif. Publ. Bot. **4**: 387. 1913

This species has been known only from the type collection, from Baños del Carrizal, Veracruz. Liebmann, however, collected ample fruiting material, of which the following collections may be cited:

MEXICO: Petlapa, *Liebmann* 11376 (Rubiaceae no. 203). Colipa, *Liebmann* 11379 (Rubiaceae no. 139). Palanque, *Liebmann* 11378 (Rubiaceae no. 138). Misantla, *Liebmann* 11383 (C; Rubiaceae no. 140).

Rondeletia Liebmannii Standl., sp. nov.

Branchlets very slender, subterete, brown, densely pilose with short spreading whitish hairs, tardily glabrate; stipules 5–6 mm. long, filiform-subulate from a short, narrowly triangular base, short-pilose or puberulent, erect, persistent; leaves opposite, those of a pair unequal, the petioles slender, 3–9 mm long, densely short-pilose; leaf blades elliptic-oblong or lance-oblong, broadest at or near the middle, 5.5–11 cm. long, 1.7–3.5 cm. wide, gradually or abruptly long-acuminate, with a narrow, often falcate acumination, acute to broadly obtuse at base, thin, deep green above, sparsely setose-hirtellous with short pale spreading hairs, the venation impressed, beneath slightly paler, densely short-pilose, at least on the nerves, with short spreading whitish hairs, the venation prominent, the lateral nerves about 9 on each side, arcuate, ascending at an acute angle, distinct nearly to the margin; inflorescence terminal, thyrsiform-paniculate, 2–4 cm. long, the peduncle about 5 mm. long, the lateral branches very short, each bearing a few-flowered dense cyme, the flowers 4-parted, the pedicels 0.5 mm. long, the branches densely short-pilose with spreading hairs; bracts linear, 3 mm. long or shorter; hypanthium densely whitish-tomentose, the calyx lobes narrowly linear, 0.5 mm. long, unequal; corolla tube very slender, 8 mm. long, pilose with short, whitish, spreading or ascending hairs, the lobes short, rounded, glabrous within, the throat naked; capsule subglobose, 3.5 mm. long, brown, obscurely costate, glabrate.

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[3] Contr. U. S Nat. Herb **23**: 1349–1394. 1926.

Type in the U. S. National Herbarium, no. 1,315,231, collected in Oaxaca, Mexico, 1841–43, by Liebmann (no. 11834).

Related to the Guatemalan *R. rufescens* Robinson, which has much denser pubescence, long panicles, shorter calyx lobes, and broad stipules.

Rondeletia polycephala Standl., sp. nov.

Branches slender, terete, blackish, densely pilose with short spreading ferruginous hairs, the internodes short or elongate; stipules persistent, thick, 7–8 mm. long, subulate from a broadly triangular base, erect, rigid, brown-pilose or glabrate; leaves opposite, sessile or nearly so, the blades oblong-ovate or ovate-elliptic, 6–12 cm. long, 2.7–5 cm. wide, rather abruptly acuminate or long-acuminate, at base broadly rounded to cordate, with deep narrow sinus, thick, deep green above, short-villous on the nerves, elsewhere very sparsely villous with very short, spreading hairs, the venation impressed, beneath densely and persistently white-tomentose, the veins stout, prominent, the lateral nerves about 9 on each side, slightly arcuate, distinct to the margin; inflorescence terminal, thyrsiform-paniculate, 4–9 cm. long, the peduncles 2.5–9.5 cm. long; flowers sessile, borne in very dense, many-flowered, headlike cymes, these sessile along the main rachis or on stout peduncles 5 mm. long or shorter, the rachis densely brown-pilose; bracts lance-oblong, 3–4 mm. long, hypanthium subglobose, nearly 2 mm. long, densely white-pilose; calyx lobes 4, unequal, oblong-ovate, 2–2.5 mm. long, obtuse, brown-pilose; corolla densely pilose outside with short spreading whitish hairs, the tube slender, 9–12 mm. long, the 4 lobes rounded, spreading, 2.5–3 mm. long, glabrous within, the throat naked; anthers included, linear-oblong, 1.5 mm. long.

Type in the herbarium of the Botanical Museum, Copenhagen, collected in Oaxaca, Mexico, by Liebmann (no. 11826). A fragmentary specimen of the same collection is in the U. S. National Herbarium. Here is referred also *Liebmann* 11836 (Rubiaceae no. 79) from Oaxaca.

The latter specimen was seen by Hooker, who labeled it "*Rondeletia* n. sp.," but apparently the plant was unknown to Hemsley, since it is not mentioned in the Biologia Centrali-Americana. In the key to the species of *Rondeletia* in the North American Flora this plant runs at once to *R. Thiemei* Donn. Smith, a Honduran species, which is not closely related.

Manettia Liebmannii Standl., sp. nov.

Plants suffrutescent, apparently scandent, the branches slender, subterete, the older ones with pale exfoliating epidermis, the young branches obscurely and very minutely puberulent, the internodes elongate; stipules 1.5 mm.

long, broadly triangular from an annular base, mucronate-acute, persistent and thickened in age; leaves opposite, the petioles stout, 2–3 mm. long; leaf blades broadly ovate to lance-ovate, 3–5 cm. long, 1–3 cm. wide, long-acuminate, with narrow obtuse acumination, at base rounded, sometimes abruptly short-decurrent, subcoriaceous, somewhat lustrous, very minutely and obscurely puberulent on the nerves or glabrous, deep green above, the reticulation of the nerves evident but scarcely prominent, beneath scarcely paler, the costa slender, prominent, the lateral nerves very slender, often nearly obsolete, 4 or 5 on each side, strongly ascending, arcuate; flowers cymose-paniculate, the panicles axillary and terminal, dense or open, many-flowered, slender-pedunculate, equaling or shorter than the leaves, the branches puberulent; bracts persistent, triangular-subulate, 1–2 mm. long; pedicels 3 mm long or shorter; flowers 4-parted; hypanthium campanulate, 0.6 mm. long, minutely puberulent; calyx lobes 4, erect, 1 mm. long, triangular to lance-oblong, acute; corolla salverform, glabrous or nearly so outside, the tube thick, 2–2.5 mm. long, the lobes broadly ovate, obtuse, 1 mm. long, short-villous within; capsule 2–2.5 mm. long, broader than long, glabrous, two-thirds inferior, shallowly bisulcate and obscurely costate, rounded-truncate at apex, rounded at base, septicidally bivalvate at apex; seeds (immature) numerous, compressed, narrowly winged.

Type in the herbarium of the Botanical Museum, Copenhagen, collected at Pelado, Mexico, August, 1842, by Liebmann (no. 11485; Rubiaceae no. 147). A fragmentary specimen of the same collection is in the U. S. National Herbarium. Collected also at San Juan de Estado by Liebmann (no. 11487).

The reference of this plant to *Manettia* is not altogether satisfactory, because of the small capsules and small flowers, but the habit of the plant suggests this rather than any other genus. By Hooker the plant was referred to *Hedyotis*, but if, as appears to be the case, the seeds are winged, it can not be referred to the Oldenlandieae. The general aspect of this plant does suggest that tribe, but there is no known American genus of that relationship to which it can be referred satisfactorily.

BOUVARDIA VILLOSA Standl. N. Amer. Fl. 32: 107. 1921

A very sharply marked and apparently rare species, known previously only from the type collection from Alturas de Matatlán, Oaxaca, *Conzatti* 1486. A Liebmann collection may now be recorded:

MEXICO: Mitla, Oaxaca, May, 1842, *Liebmann* 11051.

HILLIA TETRANDRA Swartz, Prodr. Veg Ind. Occ. 58. 1788

This species has not been known heretofore north of Guatemala, but it was collected in Veracruz by Liebmann.

MEXICO. Mirador, *Liebmann*, 11518 (C). Mecapaloo, *Liebmann* 11517 (C).

Habroneuron Standl., gen. nov.

Slender strigose shrub, apparently scandent, the branches terete; leaves opposite, short-petiolate, membranaceous, entire, finely lineolate between the nerves; stipules narrow, interpetiolar, deciduous; flowers terminal, solitary, sessile or nearly so; hypanthium oblong; calyx 4-parted, the lobes narrowly linear-attenuate, much longer than the hypanthium; corolla salverform, the tube long and slender, the limb 4-lobate, the lobes broad, imbricate, the throat sparsely papilloso-villosulous, stamens 4, linear, sessile, basifixed, inserted at the middle of the corolla tube, included; fruit unknown.

Type species, *Habroneuron mexicanum* Standl.

Habroneuron mexicanum Standl., sp. nov.

Branches very slender, flexuous, with short or much elongate internodes, dark reddish brown, glabrate in age, when young densely short-strigose with whitish hairs; stipules narrowly linear-attenuate, about 5 mm. long, thin, brownish, strigillose or glabrate on the outer surface, glabrous within, petioles slender, 3–20 mm. long, strigillose; leaf blades obovate-oblong to oblong-oblanceolate or oblong-elliptic, usually broadest above the middle, abruptly acuminate, with broad or narrow, acute acumination, at base obtuse to long-attenuate, densely strigose along the nerves on both surfaces with whitish hairs, sparsely short-strigose elsewhere, the costa very slender, prominent beneath, the lateral nerves very slender and inconspicuous, 5 or 6 on each side, ascending at an acute angle, arcuate, distinct nearly to the margin; leaf tissue conspicuously lineolate on both surfaces, but the striations irregular, not parallel, and forming a close reticulation; hypanthium 3 mm. long, 1.5 mm. thick, densely strigose; calyx lobes 8–10 mm. long, about 1 mm. wide, long-attenuate, erect, whitish-strigose; corolla densely strigose outside with long stiff whitish hairs, the tube 27 mm. long, glabrous within, the lobes broadly rounded, 5 mm. long; anthers 6 mm. long, 0.6 mm. wide.

Type in the herbarium of the Botanical Museum, Copenhagen, collected at Tintalcingo, Mexico, by Liebmann (no. 11527). A fragmentary specimen also in the U. S. National Herbarium.

Because of the lineolate leaf tissue, this plant is associated at once with such genera as *Sommera* and *Plocaniophyllon*, of the tribe Mussaendeae, but in that group the corolla lobes are valvate. In habit, leaves, and pubescence the plant suggests the genus *Sabicea*, of the same tribe, to which it must be related. The available material is, unfortunately, not ample, except in leaves and branches, and I have not felt justified in dissecting another flower besides the one which has been dissected by some earlier student.

Sommera fusca Oerst., sp. nov.

Branchlets dark reddish brown, with short internodes, when young densely hirsute with ascending or subappressed hairs, stipules 1–1.5 cm. long, caducous, narrowly lanceolate, long-attenuate, brown, sparsely hirtellous, petioles 1–2 cm. long, pilose with stiff straight appressed hairs; leaf blades oblong-elliptic to oblong-obovate, usually broadest above the middle, 5–13.5 cm. long, 2.7–6 cm. wide, obtuse or acutish at apex, usually acute at base but sometimes obtuse, thin, deep green on the upper surface, glabrous, conspicuously parallel-lineolate in the areoles, paler beneath, densely appressed-pilose with pale hairs along the nerves; inflorescences umbelliform-cymose, mostly 4 or 5-flowered, the peduncle 7–14 mm. long, densely hispidulous, the pedicels in fruit up to 6 mm. long, in anthesis much shorter; bracts caducous; hypanthium subglobose, 3 mm. long, densely appressed-pilose with fulvous hairs; calyx 3–6 mm. long, cleft nearly to the base, the 5 lobes oval to oblong, obtuse or rounded at apex, persistent, slightly accrescent in age, pubescent with short appressed hairs; corolla salverform, the tube cylindric, 8 mm. long, densely pilose with short, ascending or subappressed, pale hairs, the 5 lobes spreading, ovate, obtuse, 2–2.5 mm. long, puberulent within, the throat short-villous; fruit (probably immature) subglobose, 7–9 mm. long, hispidulous with spreading or subappressed hairs; seeds about 1 mm. long, angulate, blackish brown, foveolate.

Type in the herbarium of the Botanical Museum, Copenhagen, collected at Jocoaltepec, Mexico, June, 1842, by Liebmann (no. 11720, Rubiaceae no. 36). Duplicate specimen of the same collection in the U. S. National Herbarium.

This species is well marked by the obtuse leaves and by the broad obtuse calyx lobes.

Sommera acuminata Oerst., sp nov.

Branches very slender, somewhat flexuous, subterete, brownish, short-hirtellous, the internodes mostly 1–3.5 cm. long; stipules linear-lanceolate, 8 mm. long, long-attenuate, appressed-pilose with very short hairs, deciduous; petioles 6–11 mm. long, densely hirtellous; leaf blades lanceolate or ovate-lanceolate, 6–9.5 cm. long, 2.5–3.5 cm. wide, rather abruptly long-acuminate, with narrow, slightly falcate acumination, acute to rounded and short-decurrent at base, thin, deep green above, scabrous, hirtellous on the nerves, beneath paler, hispidulous on the nerves, the costa slender, prominent, the lateral nerves slender, about 6 on each side, arcuate, strongly ascending; inflorescence cymose, usually 3-flowered, the peduncles 1–3.5 cm. long, densely short-pilose with spreading hairs, the pedicels 3 mm. long or shorter; bracts deciduous; hypanthium 2.5 mm. long, densely hispidulous; calyx cleft to the base, the 5 lobes lanceolate, 8–10 mm. long, long-attenuate, persistent, hispidulous on both surfaces; corolla salverform, densely hispidulous outside, the tube 12 mm. long, 2 mm. thick, the lobes rounded, 3 mm. long, glabrous within; immature fruit ellipsoid, 6–7 mm. long, hispidulous, 2-celled.

Type in the herbarium of the Botanical Museum, Copenhagen, collected at Amatlán, Mexico, by Liebmann (no. 11712). A duplicate of the same collection is in the U. S. National Herbarium.

This plant is perhaps not a true *Sommera*, but it agrees in most respects with the genus to which Oersted has referred it, and there is no other genus to which it may be referred satisfactorily. The corolla is unusually slender for plants of this genus, and, of greater importance, the leaves do not exhibit the "moiree-streifung" which characterizes other plants of the genus.

Chione mexicana Standl., sp. nov.

Small tree, glabrous throughout, the older branchlets slender, subterete, grayish, the internodes mostly 1.5–3.5 cm. long; stipules lance-deltoid, 4–5 mm. long, long-acuminate, caducous; petioles 8–13 mm. long; leaf blades oval-elliptic to narrowly elliptic-oblong, 6.5–12.5 cm. long, 2–6 cm. wide, usually acute or attenuate at base, at apex abruptly contracted, with short broad obtuse tip, subcoriaceous, lustrous, deep green above, the costa and lateral nerves impressed, beneath paler, the costa slender, prominent, the lateral nerves slender, 5 or 6 on each side, prominent, ascending at an acute angle, nearly straight, coarsely and irregularly anastomosing remote from the margin; inflorescence cymose-corymbose, densely many-flowered, long-pedunculate, 2–6 cm. broad, some of the flowers sessile, the others on short stout pedicels, these in fruit sometimes 6 mm long, the bracts minute; hypanthium narrowly turbinate, 2–2.5 mm. long, the calyx limb scarcely 1 mm. long, deeply 5-dentate, the teeth broadly triangular, acute to rounded at apex; corolla 3.5–4 mm. long, the 5 lobes rounded, half as long as the tube, obscurely erose-denticulate; anthers linear-oblong, 2.5–3 mm. long, exserted, scarcely exceeding the filaments; fruit oblong-ellipsoid, 8–10 mm. long, 3 mm. thick, obtuse at base, lustrous.

Type in the U. S. National Herbarium, no. 1,266,079, collected in damp open forest at Zacuapan, Veracruz, Mexico, June, 1926, by C. A. Purpus (no. 10757). The following collections represent the same plant:

VERACRUZ: Mirador to Jalapa, *Liebmann* 11097, 11663. Papantla, *Liebmann* 11104. Mirador, *Liebmann* 11106 (C), 11099 (C; Rubiaceae no. 281), 11098 (C; Rubiaceae no. 285). Papantla, *Liebmann* 11100 (C; Rubiaceae no. 282). San Pablo, *Liebmann* 11101 (C; Rubiaceae no. 284). Paso del Correo, *Liebmann* 11103 (C; Rubiaceae no. 286). Without locality, *Liebmann* 11107, 11102 (C; Rubiaceae no 283).

This species has not been represented in the National Herbarium until recently, when specimens were received from Dr. Purpus. Hemsley[4] referred the Liebmann collections to *C. glabra* DC , a synonym of *C. venosa* (Swartz) Urban. A note by Hooker upon one of the Copenhagen sheets states that the plant is "apparently the same as *C. glabra* DC. of which *C. elliptica* Griseb. and *glabra* Griseb. are vars., but leaves membranous." Comparison with West Indian material proves that the Mexican plant is clearly distinct in its thin leaves, much smaller flowers, smaller fruit, and deeply dentate calyx. In *C. venosa* the calyx is nearly truncate.

PSYCHOTRIA BRACHIATA Swartz, Prodr. Veg Ind. Occ. 45. 1788

This species, common in some parts of Central America, has not been reported from Mexico, but the following collection may be cited:

MEXICO: Lacoba, *Liebmann* 11592.

Psychotria Chamissoana (Loes.) Standl.

Mapouria Chamissoana Loes. Verh. Bot. Ver. Brand. 65: 112. 1923.

The type, from Tecolutla ("Tecolute"), Veracruz, *Schiede* 1266, has not been seen, but the collections cited below agree with the description. Loesener reports the species also from Nentón, Guatemala.

MEXICO: Consoquitla, *Liebmann* 11601 (C), 11655 (C; Rubiaceae no. 156). Without locality, *Liebmann* 11654 (Rubiaceae no. 154). Zacuapan, Veracruz, *Purpus* 10889.

Psychotria flava Oerst , sp. nov.

Young branches very thick and stout, with short or elongate internodes, subterete or obtusely quadrangular, sometimes puberulent at the nodes but elsewhere glabrous; stipules quickly deciduous, broadly ovate-triangular, 1.5 cm. long, narrowed to the apex and shallowly cleft, the apical lobes 1–1.5 mm. long, densely ferruginous-puberulent on the outer surface, leaves opposite, the petioles stout, 0.5–2 cm long, densely puberulent or short-pilose; leaf blades narrowly oblanceolate-oblong to obovate-oblong or sometimes linear-oblanceolate, mostly 18–32 cm. long and 2.5–13.5 cm. wide, acute to obtuse, usually cuneate-attenuate at base, thick, yellow-green and glabrous above, the lateral nerves prominent, beneath dull, minutely hirtellous on the nerves and puberulent between them, the pubescence persistent, the costa stout, prominent, the lateral nerves slender or stout, prominent, 19–26 on each side, arcuate-ascending, distinct nearly to the margin; inflorescence terminal, capitate-paniculate, the panicles radiately branched, 5–10 cm. long, the peduncle stout, erect, 6.5–9 5 cm. long, the branches densely hirtellous; branches of the panicle verticillate, 8 or fewer branches in each whorl, the primary branches 1.2–2 8 cm long, divaricate, bearing usually 3 pedunculate, subglobose, few or many-flowered heads 4–6 mm. in diameter; hypanthium and calyx tomentulose, the calyx limb less than 1 mm. long, truncate or obscurely repand-denticulate, 1.5 mm. broad; corolla 4.5 mm. long, salverform, glabrous, the tube widened upward, the lobes ovate, obtuse, 1.5 mm. long; anthers exserted, oblong, 1 mm. long; fruit subglobose or obovoid, 8–15 mm. long, glabrous, rounded to acute at base, the cells plane on the inner surface, stones obtusely costate dorsally; seeds shallowly sulcate on the inner surface

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[4] Biol Centr. Amer. Bot 2: 45 1881.

Type in the herbarium of the Botanical Museum, Copenhagen, collected at Misantla, Veracruz, Mexico, by Liebmann (no. 11605). The following collections are conspecific:

MEXICO: Misantla, *Liebmann* 11506 (C). Comaltepec, *Liebmann* 11630 (C). Without locality, *Liebmann* 11604 (Rubiaceae no. 108), 11602 (Rubiaceae no 108) Jovo, May, 1841, *Liebmann* 11603.

The species is distinguished by the large narrow yellowish leaves, copiously pubescent beneath, and by the characteristic inflorescence.

Psychotria gardenioides (Scheidw.) Standl.

Rhodostoma gardenioides Scheidw. in Otto & Dietr. Allgem. Gartenzeit. **10**: 286 1842

Palicourea gardenioides Benth. & Hook., Hemsl. Biol. Centr. Amer. Bot. **2**: 52. 1881.

When manuscript was prepared for the Trees and Shrubs of Mexico, no authentic material of this plant was available for study, and it was listed[6] as a doubtful species. In the Liebmann collection there are several specimens referable to this species, some of which were identified by Hooker. The plant represents a very distinct species, quite unlike any other known to me. The limits between the genera *Psychotria* and *Palicourea* are notoriously vague, but this plant, it seems to me, may be placed in the genus *Psychotria* much more satisfactorily than in *Palicourea*. The following collections may be cited:

MEXICO: Without locality, *Liebmann* 11554 (C), 11553 (C), 11591 in part (C), 11548 (C; Rubiaceae no. 100), 11549 (C, Rubiaceae no. 98). Chuapan, *Liebmann* 11548 (C, Rubiaceae no. 101). Casadero, *Liebmann* 11549 (C; Rubiaceae no. 97). Jecatepec, *Liebmann* 11550 (C; Rubiaceae no. 99). Cuapan, *Liebmann* 11552 (C). Paso del Correo, *Liebmann* 11551 (Rubiaceae no. 95). Tampico, *Palmer* 516.

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[6] Contr. U. S Nat Herb **23**: 1392 1926

PSYCHOTRIA ULIGINOSA Swartz, Prodr. Veg. Ind. Occ. 43. 1788

The species has not been reported from Mexico, but two collections may now be listed:

MEXICO: Jovo, *Liebmann* 11650. Without definite locality, *Liebmann* 11651 (C).

Faramea Liebmannii Standl., sp. nov.

Glabrous throughout; young branches slender, subterete, the internodes 2.5–5.5 cm. long, green; stipules green, 4–5 mm. long, united into a sheath, the free portion semiorbicular, subulate-mucronate, the mucro 1.5–2 mm. long; petioles stout, 6–8 mm. long; leaf blades narrowly oblong, 12.5–17 cm. long, 3.5–4.5 cm. wide, rather abruptly short-acuminate, with narrow obtuse tip, attenuate to the long-acuminate base, broadest at the middle, thin, bright green, concolorous, the costa stout, prominent, the lateral nerves slender, prominent, about 13 on each side, divergent at a wide angle, slightly arcuate, irregularly anastomosing remote from the margin; inflorescence terminal, sessile, branched from the base, the branches slender, few-flowered, the whole inflorescence about 2.5 cm. long, pedicels 1.5–5 mm. long; hypanthium 1.5 mm. long, oblong, the calyx 0.6 mm. long, truncate or obscurely denticulate, green; corolla salverform, the tube 2 mm. long, the lobes spreading, linear-oblong, obtuse, 5 mm. long, anthers linear, 1.5 mm. long, exserted.

Type in the herbarium of the Botanical Museum, Copenhagen, collected at Tepitapa, Mexico, by Liebmann (no. 11404; Rubiaceae no. 105). A duplicate specimen of the same collection is in the U. S. National Herbarium.

Only one other species of the genus, *Faramea occidentalis* (L.) A. Rich., has been reported from Mexico, and to that the present plant is not closely related. It is amply distinct, also, from the few species which are known from Central America.

MITCHELLA REPENS L. Sp. Pl. 111. 1753

It is truly remarkable that this common plant of the eastern United States should reappear in southern Mexico, but Hemsley, in the Biologia Centrali-Americana, cites two records for it. The plant was collected also by Liebmann (no. 11804) at Tanetze, Mexico. It seems not to have been found by recent collectors, and the species has not been represented heretofore in the National Herbarium by Mexican specimens. Liebmann's material, although incomplete, seems to differ in no respect from the common form of the United States.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

951ST MEETING

The 951st meeting was held at the Cosmos Club February 17, 1927, as a joint meeting with the WASHINGTON ACADEMY of SCIENCES. The address of the evening was given by Dr. ARTHUR HAAS of Vienna on *The atom as a source of energy.*

952D MEETING

The 952d meeting was held at the Cosmos Club February 19, 1927.

Program: ROBERT B. SOSMAN, *The character of the 573-degree of inversion of quartz.* The paper dealt with the so-called alpha-beta or "high-low" reversible inversion which occurs in quartz at 573°C. (adopting the value found for the point by Bates and Phelps). This is an inversion of very different type from the sluggish inversions between quartz, tridymite, and cristobalite, but similar in many ways to such polymorphous inversions as the magnetic inversion in pure iron, characterized by rapidity of change, complete reversibility, small energy-change, and slight modifications in the structure of the substance Graphs showing the character of the change of various mechanical, thermal, and optical properties were presented. Some of the questions that need experimental study are: (1) Is there a real discontinuity in properties at 573°, or can the change be represented simply by two continuous curves which intersect? The data favor the existence of a discontinuity. (2) Is there a temperature-hysteresis in the inversion? The data on this point are less certain, but such hysteresis (independent of time) seems to be present (3) Is the change in properties simultaneous for all properties? There is evidence that the optical change precedes the volumetric. (4) Is there ever an equilibrium between the high-temperature and low-temperature phases? The change appears to be unlike a melting-point, and resembles rather a mechanical or electrical system which passes through a region of instability (*Author's abstract.*)

W. P. WHITE, *One bit of evidence regarding the relation of chalcedony to quartz.* In the actual carrying out of calorimetric experiments at high temperatures there are numerous difficulties, of which the most impressive and usually the most serious is the enormous increase in thermal leakage or heat transfer. In order to cope with this difficulty the maximum shortening of time is desirable, which usually leads to small dimensions, even though these, on account of the unfavorable relation of surface to mass which they bring, still further increase the thermal leakage rate. A well-known and exceedingly valuable resource is to compare two calorimeters, reading the differential temperature. Irregularities in the leakage rate and uncertainty as to the supply of heat from the furnace walls thereby have their effects greatly lessened. I formerly disparaged this method on account of the complications it introduced, but these seem small compared to the advantages. When all has been done, however, the best precision obtainable by such methods is little better than 1/100 as good as is obtainable at prevailing room temperatures.

The exact nature of chalcedony has been in doubt for some time. Microscopic evidence has indicated that it is a rather peculiar form of quartz. But

Fenner showed conclusively that chalcedony failed to manifest the characteristic quartz inversion when tried with apparatus which had given this inversion easily with normal quartz. Since he was working under the natural supposition that chalcedony either was quartz or was not, he saw no reason to scrutinize his negative result any further. Subsequently E. W. Washburn reported that chalcedony gives the X-ray pattern of quartz, and Dr. R. B. Sosman, from a study of Fenner's original observations, detected some evidence of the quartz inversion and suggested that further experiments might be worth while. An examination with duplicate calorimeters especially arranged for this test readily gave unmistakable signs of the quartz inversion, though in a strikingly different form from that manifested in the same apparatus by quartz. The inversion in chalcedony is completed at practically the same temperature as that in quartz within the precision of the experiment, which is probably better than a degree, but the inversion in chalcedony undoubtedly begins at a lower temperature. Whether the total amount of heat involved is as great as with quartz can not be told from the results so far obtained, and further work is in preparation. (*Author's abstract.*)

FREDERICK BATES and FRANCIS P PHELPS, *The 573-degree inversion of quartz.* The $\alpha \rightleftarrows \beta$ inversion of crystalline quartz has long been extensively studied, using nearly all major physical phenomena as a means of attack and culminating in the recent work of the elder Bragg and his associate Gibbs. Its bearing on the general theory of allotropy is important. In the present investigation the principal experimental results obtained are as follows:

(1) It has been possible for the first time to study the phenomena at practically the inversion temperature.

(2) The heating and cooling curves have been obtained with a precision higher than that obtained by previous investigators.

(3) There is a temperature hysteresis effect.

(4) There is a discontinuity during inversion.

(5) Superheating and supercooling are essential to bringing about the inversions The inversion starts on heating at 573.30°C. and on cooling at 572.38°C.

(6) The discovery of the character of the inversion makes possible the application of the Phase Rule for the determination of the temperature of equilibrium of the two solid phases. This is found to be 572.68°C and is the true inversion temperature. The long-accepted value of the inversion temperature, 575°C, is in error.

(7) The unknown heat of transition (latent heat) has been determined at 0.162 g. cal.

(8) The unknown specific heat of α quartz at the inversion temperature is found to be 0 54 g. cal

(9) An explanation of the mechanism of the inversion is given.

(10) The temperature at which the inversion starts, 573 30°, is a fixed and definite temperature occurring with great sharpness and suitable for a new type of base point on the thermometric scale, as well as for the standardization and checking of thermocouples in the average physical laboratory. (*Author's abstract*)

953D MEETING

The 953d meeting was held at the Cosmos Club March 5, 1927.

Program: PAUL SCHUREMAN, *Tides in wells.* Attention was called to the fact that periodic rising and falling of the water in some wells, corresponding to the tides in the open ocean, had been noted by Pliny the Elder as early as the first century of the Christian Era. Reference was made to an investigation of tidal fluctuations in wells on Long Island, New York, by the U. S. Geological Survey during the early part of the present century and also to investigations of tides in a well at Tarka Bridge Farm in South Africa. The latter investigation by Dr. Arthur Young in 1905 and 1908 developed a periodic tide of seven inches in amplitude in a well which is one hundred miles from the seacoast and about half a mile above sea level.

The paper dealt principally with tide observations in a well at Longport, New Jersey, which were obtained through a cooperative arrangement between the New Jersey Department of Conservation and Development and the U. S. Coast and Geodetic Survey. These observations covered a period of more than a year. This well, which is eight hundred feet deep, is located about five hundred feet from the ocean shore and during the observations the water level in the well varied from 15 to 31 feet below mean sea level.

The mean range of the periodic tide in the well was 2.3 feet which is a little more than one-half as great as in the open ocean in this vicinity. Comparisons were made with the records from the Coast and Geodetic Survey tide station on Atlantic City Steel Pier and it was found that on an average the times of high and low waters in the well were ±2 to 14 minutes later than in the ocean Various irregular fluctuations of the ocean level due to meteorological disturbances were reflected by corresponding fluctuations on a smaller scale in the well.

It was concluded that the tides in the well were caused by the deformation of the strata of clay overlying the water-bearing area, the water being forced into the well and drawn out again by bending of the strata as the load of water in the nearby ocean was shifted by the rising and falling of the tide. (*Author's abstract*).

L. J. BRIGGS, *High-frequency fatigue testing of metals*

JESSE PAWLING, in an informal communication, spoke of an unexplained small difference in the observed position of the nadir, depending upon the position of the observer with respect to the observing instrument.

H. E. MERWIN, *Recording Secretary.*

BIOLOGICAL SOCIETY

699TH MEETING

The 699th meeting was held in the assembly hall of the Cosmos Club on December 18, 1926, at 8:10 p m, with President OBERHOLSER in the chair, and 67 persons present.

The President read a letter from Mrs. RENA G KNOWLTON in reply to a letter of condolence from the Council of the Biological Society on the death of Dr. KNOWLTON. T. S. PALMER referred to the services of Dr. KNOWLTON to the Society during his 42 years' membership, of which he served 14 as treasurer, 4 as vice-president and 2 as president. He was active in both zoology and botany, and did much work in compiling botanical definitions for dictionaries and encyclopedias.

A. WETMORE reported two birds new to Maryland, which will be recorded in a forthcoming number of the "Auk." He also reported the observation by E. A. Preble and himself of a snowy owl, horned larks, and a northern shrike about one mile below Ocean City, Maryland, on December 4, 1926.

T. S. PALMER stated that three snowy owls had recently been taken close to Washington (at La Plata, Md., Lanham, Md., and at Belmont Bay on the Potomac near Occoquan). Three others had also been reported at greater distances from Washington.

E. A. GOLDMAN reported that he had been informed that the snowy owl was not uncommon in winter on the northern coast of Washington.

DUNCAN S. JOHNSON, Johns Hopkins University. *The Blue Mountains of Jamaica and their vegetation (illustrated).*—The Blue Mountains of Jamaica catch the northeast trade winds, so that the steep north side is very wet, the rainfall reaching 170 or even 200 inches, while on the south side it is much less. The vegetation varies correspondingly. The speaker described a trip from Port Antonio across the mountains to Kingston and then up to Cinchona at an elevation of 5,000 feet. Slides of the characteristic wild and cultivated plants were shown, and the process of collecting and curing coffee was described.

F. C. LINCOLN, Biological Survey: *The migration of young herring gulls (illustrated).*—This paper will be published in the "Auk."

700TH MEETING

The 700th meeting of the Biological Society was held in the New Assembly Hall of the Cosmos Club on January 15, 1927, at 8:10 p.m., with President OBERHOLSER in the chair and 51 persons present.

TITUS ULKE exhibited a book of pressed specimens of mermaid weed, also bladderworth and other plants from Norway.

C. W. STILES referred to newspaper accounts of the studies of Dr. SAMBON on the parasitic origin of cancer in the intestinal canal. This is a subject at present in controversy, especially in England. Dr. STILES' own examinations never resulted in finding any association between nematode parasites and cancer (carcinoma) in the oesophagus of cattle, and experiments on rats, by him and Mrs. BAKER, were negative and do not support SAMBON's hypothesis. Dr. BARTSCH asked if there was a possibility of a secondary parasite being involved, i.e., protozoa—a filtrable virus—associated with nematodes. Dr. STILES replied that while protozoa have been described as causing cancer, it is still unproved. Cancer is not to be reduced to any one cause.

FRANK THONE of Science Service referred to a telegram to Science Service in regard to the Scopes trial and stated that newspaper accounts were not quite correct or complete, i.e., the fine was reduced, the law was held constitutional but probably limited so that only materialistic philosophy cannot be taught. The case will probably be "nolle prossed."

Dr. OBERHOLSER read a letter from Dr. M. W. LYON of South Bend, Ind., a former secretary of this Society, congratulating the Society on its 700th meeting.

The regular program was as follows: *The Biological Society of Washington—past, present, and future,* by four speakers. *Early days of the Society*—An historical survey by T. S. PALMER. An interesting and humorous account of *High lights in our history,* by L. O. HOWARD. *Our present membership,* a geographical and statistical survey by F. C. LINCOLN. A program for broader and greater contacts and future growth under *Plans for the future,* by PAUL BARTSCH.

A. S. HITCHCOCK gave a brief account for the activities of botanist members of the Society and to what extent they have taken advantage of the Proceedings.

701ST MEETING

The 701st meeting was held in the assembly hall of the Cosmos Club January 29, 1927 at 8:10 p.m., with President OBERHOLSER in the chair, and, 73 persons present. The following new members were elected: W. F. ALDERSON, GEORGE ARONSON, MARGARET BOSWELL, C. W. COLE, W. L. HALL, W. C. JOHNSON, HARRY LEPMAN, H. A. LINDSLEY, P. H. LOWREY, BERNARD McBRIDE, PEREZ SIMMONS, VIRGINIA J. STORCK, JAMES SUTER, D. M. TAYLOR, R. E. WESTER, M. FRANCES WILLOUGHBY, ELSIE S. WRIGHT.

VERNON BAILEY reported evidence indicating that the opossum does not really hibernate. Last fall one took up its abode under his back doorstep, where it made a warm nest of leaves, and was kept supplied with food and drink through the winter. On two occasions the thermometer fell to 8°F., and on others it was from 12 to 18°F. On the coldest morning a thermometer pressed into the fur gave an outside body temperature of 75°, showing that the animal was not torpid. These observations raised the question whether other carnivores such as bears and raccoons really hibernate. In real hibernation, the animal is without evidence of breathing, and the external temperature drops to about 44°.

A. S. HITCHCOCK reported the action of the International Congress of Plant Sciences at Ithaca in 1926 in regard to nomenclature with special reference to the interim committee there appointed.

J. N. ROSE exhibited a photograph of a woodpecker nest in a giant cactus in Arizona. H. C. OBERHOLSER stated that in some places it had been necessary to replace wood telephone posts by iron ones, because of the damage done by woodpeckers.

The regular program was as follows.

C. W. STILES: *Personal experiences with Elias Metchnikov.* The speaker gave interesting personal reminiscences of Metchnikov.

VERNON BAILEY: *Mouse plagues and how they happen* (*illustrated*).—Accounts of mouse plagues go back fully a thousand years. They have been especially prevalent in south central Europe, where all the crops have often been destroyed. The first definite record of a mouse plague in this country is in 1907, when great alfalfa ranches in the Humboldt Valley, Nevada, were temporarily ruined by *Microtus montanus*. The use of poison, supplemented by the efforts of gulls, herons, crows, birds of prey, and carnivorous mammals, reduced the numbers to normal before the close of the season. The speaker has raised meadow mice in captivity to learn their normal rate of increase. Under optimum conditions a family of 6 to 8 is produced regularly every 21 days. One female in one year gave birth to 18 families, including about 79 young. The first family was born when the mother was 45 days old. Mathematical investigation showed that under optimum conditions one pair would increase at the end of a year to over one million individuals. It is evident that a plague comes about when plenty of food is available and when the mice are protected from their natural enemies.

In discussion, C. W. STILES spoke of the disease known as dirt eating in man and animals, with special reference to the case of the negro in the South in which the disease took the form of eating live mice.

P. B. JOHNSON stated that there was a discussion of mouse plagues of antiquity in the bulletin on meadow mice by the late D. E. LANTZ. He spoke also of the mouse gods of the Mediterranean region, and the connection of Apollo under the name Apollon Smintheus with plagues of mice.

702D MEETING

The 702d meeting was held in the new assembly hall of the Cosmos Club, February 12, 1927, at 8:10 p.m., with President OBERHOLSER in the chair and 300 persons present. New member elected: R. KENT BEATTIE.

J. N. ROSE: *The distribution of the cacti (illustrated).*—The speaker gave an account of his field work while carrying on investigations of the cactus family, during which he visited practically all the great cactus regions of North and South America. Four journeys were made to South America, where many new and rare species of cacti were collected. The cactus family is purely an American one, and about equally distributed between North and South America. The species of South America are nearly all different from those of North America, and usually belong to different genera. Some of the genera found in western Argentine simulate genera to be found in New Mexico and in Arizona, but are quite distinct. This resemblance is also to be found in other groups outside of the cacti, as for instance the creosote bush and palo verde. Many cacti have been introduced into the Old World. Some of the species have become a great pest in Argentina by overrunning the rich wheat fields. The cactus is also very abundant in parts of Africa and southern Europe and in Palestine. Some artists who had visited Palestine, but did not know that the cactus is there an introduced plant, had shown in their canvases biblical characters standing beside these introduced cacti. The cactus family is now represented by about 120 genera and contains more than 1200 species. The lecture was illustrated by numerous colored slides.

S. F. BLAKE, *Recording Secretary.*

President OBERHOLSER expressed the sorrow and sympathy of members of the Biological Society at the death of Dr C. D WALCOTT, Director of the Smithsonian. Dr. WALCOTT was a former vice-president of this society.

A. A. DOOLITTLE exhibited two jars, hermetically sealed for over two years, containing growing plants; in one jar containing carbon dioxide, algae, grass-like plants, and ferns were living; in the other jar containing fresh air was a living fern.

The regular program was as follows:

T. S. PALMER: *The personality of Thomas Nuttall*—The speaker gave interesting data on the habits and work of Nuttall.

E. P. WALKER: *The present status of wild life in Alaska* (illustrated).—(No abstract received.)

W. M. MANN: *The Smithsonian-Chrysler Expedition to Tanganyika* (illustrated).—The speaker gave an account, illustrated by motion pictures, of the expedition and its method of capturing and bringing back alive African mammals and birds

T. E. SNYDER, *Secretary pro tem.*

703D MEETING

The 703d meeting was held in the new assembly hall of the Cosmos Club February 26, 1927, at 8 pm., with President OBERHOLSER in the chair and 102 persons present.

C. W. STILES inquired how it was known that the jars containing living plants exhibited at the previous meeting were hermetically sealed. Mr. DOOLITTLE replied that they were ordinary Mason jars with the covers tightly screwed down on the rubbers.

J. M. ALDRICH reported the death of Dr. Mario Bezzi, the prominent Italian dipterist.

J. M. **Aldrich**: *Thomas Say, naturalist* (illustrated).—Thomas Say, born in 1787, was the son of a Quaker apothecary of Philadelphia. He made a collecting trip along the Atlantic Coast of Georgia and Florida in 1818, and was on Long's expedition to the Rocky Mountains in 1819, and also on Long's 1823 expedition to the source of the Missouri River. It is possible that he also made a trip to Mexico. He was one of the members of Robert Owens' colony at New Harmony, Indiana, where he stayed until his death in 1824. He wrote on many zoological subjects

In discussion, Dr. **Palmer** referred to Say's ornithological work. It is generally believed that most of the bird specimens of the Long expeditions were collected by T. R. Peale. Dr **Stiles** mentioned that some ticks and crustacea important in medical zoology were described by Say.

A. S **Hitchcock**: *A recent botanical trip to Cuba* (illustrated).—The speaker spent about four weeks in Cuba during November and December 1926, visiting Pinar del Rio, Soledad, Baraguá, Guaro, and Camaguey At Pinar del Rio he collected grasses in the pine woods in company with Brother Léon and Professor Roig, both well-known botanists of the Island At Soledad, near Cienfuegos, is Harvard House, a laboratory associated with Harvard University and offering facilities to visiting biologists for natural history studies. Baraguá, a *central* on a large sugar estate, is the seat of a laboratory of the recently organized Tropical Plant Research Foundation. Guaro, near Preston, in the province of Oriente, is the headquarters for agricultural research on the estates of the United Fruit Company Herradura, the home of Professor F. S. Earle, in the province of Pinar del Rio, was also visited. Professor Earle, formerly Director of the Cuban Experiment Station at Santiago de las Vegas, is now sugarcane technologist for the Research Foundation mentioned above. Many interesting grasses obtained on the expedition through the Island are now being studied. (*Author's abstract.*)

E A. **Goldman**: *Conditions affecting migratory waterfowl in Mexico* (illustrated) —The protection of migratory birds, especially of such waterfowl as ducks and geese that are much hunted as game, is a subject for international consideration. The speaker spent the time from January 25 to April 6, 1926, in Mexico, visiting the principal wintering grounds of these birds to investigate the occurrence and distribution of the various species and to secure other information concerning conditions in that country with a bearing upon the administration of the Migratory Bird Treaty Act with Great Britain, through the Biological Survey, U. S Department of Agriculture. The principal regions visited were the Valley of Mexico, in the Federal District, the Valley of Toluca, in the State of Mexico, Lake Patzcuaro, in Michoacan, Lake Chapala, in Jalisco, Tampico, in Tamaulipas, the lake region of southwestern Coahuila and northeastern Durango, lakes west of the City of Chihuahua, and lagoons near the mouth of the Rio Grande. The investigations revealed the fact that great numbers of northern ducks, including the pintail, shoveller, canvas back, redhead, lesser scaup, blue-winged, green-winged and cinnamon teals, white-fronted and snow geese and other waterfowl winter in the regions visited. Special attention was given to the use of guns set in batteries for killing ducks for the market in and near the Valley of Mexico. (*Author's abstract*)

704TH MEETING

The 704th meeting was held in the new assembly hall of the Cosmos Club March 12, 1927, at 8.00 p.m , with President **Oberholser** in the chair and 101 persons present. New members elected: Miss **Penelope Graham**, Miss **Pearl Hicks**, **Kenneth E. Hobbs**, Miss **E W. Scott**, Miss **Lillian T. Smith**.

Alexander Wetmore mentioned the receipt of Oligocene bird fossils from Colorado.

Paul Bartsch stated that the mockingbird, which has wintered in his yard for a number of years, has learned to mimic perfectly the whistle used by Mrs. Bartsch in calling him to food.

A. S. Hitchcock reported the substance of a recent discussion in the Journal of Economic Biology on the place of the systematist in biological work. Discussed by Dr. **Bartsch** and Dr. **Howard**

S. F. Blake: *Frederick Pursh, an early American botanist.*—Frederick Pursh, author of the only complete flora of the United States and Canada ever published, was born at Grossenhayn, Saxony, on February 4, 1774, and died at Montreal in 1820. After studying at Dresden, he came to America in 1799 to take charge of a botanic garden near Baltimore. Most of his 12 years in the United States were spent in charge of botanic gardens, including those of William Hamilton (1802–05) and Dr. David Hosack (1807–1810). With the financial support of Dr. B. S. Barton, Pursh made a collecting excursion in 1806 from western Maryland to the mountains of North Carolina, returning by the coast, and another in 1807 to the Pocono Mountains of Pennsylvania, the salt springs in the vicinity of Onondaga, New York, and Oswego, on Lake Ontario, thence east to the Champlain Valley and the vicinity of Rutland, Vermont. In 1810–11 he made a voyage to the West Indies for his health. On his return he landed at Wiscasset, Maine, and visited Dr Peck's garden at Cambridge on his way to New York. In 1811 he went to London, where, under the patronage of A. B. Lambert, he completed his "Flora Americae Septentrionalis," published early in 1814 (probably in January). Little is known of Pursh's life after this. He came to Canada, collected materials for a flora of that country, which were destroyed by a fire, and died soon after. (*Author's abstract*).—Discussed by W. A. **Dayton**, R. K. **Beattie**, and W. W. **Eggleston**

W B. Bell: *Some biological relationships and their significance.* The speaker called attention to the tendency of the human mind to satisfy itself by naming objects or phenomena and to cling tenaciously to such expressions, thus often building up a wall of words which obscures the essential considerations or problems involved. He stressed the need for constant critical reexamination of established notions to eliminate untenable statements or interpretations and make possible genuine progress through direct incisive thinking, both in research and the applications of scientific results to industry and human well being. As an illustration he discussed the commonly used expression, "Balance of Nature," pointing out that while it rests upon a sound basis it has been subjected to much abuse through improper interpretation and application. The essential facts have been obscured by a mass of fictitious interpretations of relationships among animals, plants, and mankind. Along with elements of stability there is in nature constant ebb and flow, a condition which, if overlooked, result in snap judgment and improper conclusions

That fluctuation and change is the regular course of events in nature was supported by reference to records of paleontology Some recent instances of fluctuation in numbers and relationships of animals such as porcupines, mice, and rabbits, were noted, and attention called to inadequate explanations based on faulty conceptions of the principle of balance in nature as a factor in control. These have misled both scientists and the general public with the result that more vital control agencies have been long overlooked.

This has retarded research on such essential factors as competition, parasites, and diseases. The intricate relationship and far-reaching importance of tularemia among rabbits, involving in its course, ticks, flies, other rodents, predacious species, and man, was cited as a case in point. The need was emphasised for more extensive research in the relationship of the parasites of wild species to wild and domesticated animals and of the food habits of rodents, predatory animals and big game, to livestock and agricultural production, in order to secure a sound basis of fact for consideration in working out conservation and control programs.

C. F. M. SWYNNERTON, Chief of Game Preservation Department, Tanganyika Territory: *The tsetse fly problem in Tanganyika* (illustrated). The speaker described the efforts being made to combat the tsetse fly by the destruction of bush growth, on which it is dependent, and illustrated his talk by numerous lantern slides.

705TH MEETING

The 705th meeting was held in the new assembly hall of the Cosmos Club on March 24, 1927, at 8 p.m., with President OBERHOLSER in the chair and 95 persons present.

L. O. HOWARD: *An anecdote concerning a famous pathologist and an equally famous parasitologist.*--The speaker related some amusing anecdotes relating to Dr. Raphael Blanchard and Dr. A. Laveran. Discussed by Dr. STILES, who gave interesting personal glimpses of Dr. Blanchard.

C. D. MARSH: *Coyotillo, a peculiarly dangerous stock-poisoning plant.* (illustrated). This paper will be published in full elsewhere.

P. H. DORSETT: *Plant hunting with the camera in North China, Ceylon, Sumatra, and Java* (illustrated).—The speaker described his experiences in collecting plants and seeds for the Department of Agriculture and illustrated his talk by many colored slides.

706TH MEETING

The 706th meeting was held in the new assembly hall of the Cosmos Club April 9, 1927, at 8:10 p.m., with President OBERHOLSER in the chair, and 92 persons present. New member elected: J J. CARROLL.

S. F. BLAKE reported that purple grackles are again roosting at night in the Trinity College grounds, as in previous years.

A S. HITCHCOCK reported a case of synonymy in grasses

C. W. STILES: *Rudolph Leuckart, the greatest teacher I have ever known.* The speaker gave an interesting and intimate account of Rudolph Leuckart, under whom he studied.

A. S. HITCHCOCK: *The typification of Linnaean plant genera.* The speaker presented a brief account of his work in preparing a list of types for Linnaean genera in cooperation with the botanists at Kew.—Discussed by Dr. STILES and Dr. HOWARD.

A. DO AMARAL: *Snakes, venoms, and antivenins* (illustrated). There are perhaps 500 species of poisonous snakes in the world. The venoms are very complex, each one hitherto studied consisting of from 8 to 20 different principles. In general, the secretions of perhaps 95 per cent of known snakes are venomous, but most of them have no fangs for the injection of poison. Each venom must be treated with a different antivenin. The different types of poison apparatus were described and illustrated. At least 1500 people in the United States are bitten by poisonous snakes every year. The mortality, so far as known, ranges from 15 to 75 per cent, depending largely on the size of the snake and the corresponding variation in the amount of venom secreted. The method of capturing poisonous snakes to extract the venom for use in the preparation of antivenin was described and illustrated. The serum most widely distributed at present by the Antivenin Institute is a polyvalent serum, applicable to cases of poisoning by rattler, copperhead, and water moccasin. The immunity conferred by the use of this serum lasts about ten days. The production of specific antivenins is being carried on, and a wider use for them is expected in the future. The polyvalent serum now used is made necessary by the fact that people do not distinguish the species of poisonous snakes sufficiently accurately to make it safe in general to apply specific serums.

707TH MEETING

The 707th meeting was held in the new assembly hall of the Cosmos Club April 23, 1927, at 8:10 p.m , with President **OBERHOLSER** in the chair and 65 persons present. The minutes of the preceding meeting were read and approved. New members elected: Miss **CLARIBEL R. BARNETT**, **WM. T. COX**, Miss **ANNIE L. DAVIS**, **D. W. SLAUSON**, and Dr. **G. H. WHITE**.

The first part of the meeting was devoted to brief notes on birds and was opened by **H C. OBERHOLSER**, who described the abundant waterfowl on the Potomac River in recent years. Whistling swan have returned to the Washington region and are especially abundant at Widewater on the Potomac. Canvasback have greatly increased in numbers and as many as 100,000 have been observed on Broad Creek near Fort Washington. A raft of 120,000 scaup was seen at Occoquan during the past winter. Early in the season the best place to observe ducks is at Indian Head or below; later on between Washington and Mt. Vernon.

Mrs. **L. D. MINER** described the last trip of the Audubon Society, on which 76 species were observed.

IRWIN HOFFMAN stated that he had recently seen a kingfisher entering the same hole in which he found it nesting eleven years ago.

M. K. BRADY mentioned the observation of phoebes along the Potomac in December and February and inquired what they fed upon. **S. A. ROHWER** replied that insects were about during the winter, but flew only on warm days.

Miss **M. T. COOKE** reported that practically all birds due to arrive by April 28 have now been reported. Two early records have been broken, those for the yellow-throated warbler and white-crowned sparrow.

VERNON BAILEY reported his observation of trumpeter swans in Yellowstone Park, where they have been found for seven years past During the past season he saw three pairs there, two of them with young.

WILLIAM B. BELL reported his observations on nesting Caspian tern, white-faced glossy ibis, and other birds in southern Oregon in 1926.

R. M. LIBBEY reported that in Haskin's "Book of answers," it was stated that the nighthawk makes the longest flight from its breeding ground of all birds, and inquired whether this was correct. **H. C. OBERHOLSER** stated that the Arctic tern makes the longest flight.

The regular program was as follows:

F. C. LINCOLN: *Flight lines of ducks.* A study of the data represented by the 3,867 returns obtained from 19,578 banded ducks and geese shows important details of the migrational highways followed by these birds.

It is noted that even with species that are more or less continental in their distribution, there is a marked adherence to longitudinal zones. Briefly, these zones are represented by the eastern and western parts of the country, the one hundredth meridian forming the dividing line. This is demonstrated by the relatively small number of birds that, banded either to the east or west of this line, have been recovered on the opposite side while in the United States. On the great breeding grounds of the central provinces of Canada and on the wintering grounds of the Gulf coast of the United States, there is a convergence of lines otherwise widely separated.

The importance of these data is obvious, in connection with the serious conditions existing at several points in the West, where annual losses of wildfowl from alkali poisoning presents a serious problem in conservation. Such information shows conclusively that a relative abundance of ducks and geese in the Mississippi Valley and on the Atlantic coast can not be expected to restore the equilibrium and offset the losses in the western zone. (*Author's abstract.*)

T. S. PALMER: *Intensive bird study in the suburbs of large cities.* The speaker drew attention to the fact that the suburbs of large cities are especially favorable places for bird study due to the existence of permanent organizations of persons interested and to the presence of museums. Statistics were given for Cambridge, New York, Philadelphia, Washington, Chicago, and San Francisco. The local organizations in these places were described and some of their special activities.

A. H. HOWELL: *Some recent bird notes from Florida.* The speaker has made seven trips to study the animal life of Florida since 1918. The State list of birds now includes 412 species and subspecies Among the birds of especial interest are pelican, sandhill crane, spoonbill, wood ibis, white ibis, limpkin, everglade kite, and great white heron. The habits of these birds were described and illustrated by photographs.

708TH MEETING

48TH ANNUAL MEETING

The 708th regular and 48th annual meeting of the Biological Society was held in the new assembly hall of the Cosmos Club May 7, 1927, at 8 p.m., with President OBERHOLSER in the chair and 18 persons present The minutes of the preceding annual meeting were read and approved. The president spoke of the past year as one of the most successful in the history of the Society.

T. S. PALMER, one of the delegates to the 200th anniversary meeting of the American Philosophical Society, gave an informal report of the occasion. The reports of the recording secretary, corresponding secretary, treasurer, and Committee on Publications were read and ordered placed on file The report of the Auditing Committee was read T S PALMER gave an informal report for the Trustees of Permanent Funds.

The president appointed I HOFFMAN and Mrs T. E SNYDER as tellers and the following officers were then elected:

President, E A. GOLDMAN; *Vice-Presidents*, A. WETMORE, G. E. CHAMBLISS, H H T. JACKSON, C W STILES· *Recording Secretary*, S. F. BLAKE; *Corresponding Secretary*, T E. SNYDER, *Treasurer*, F. C. LINCOLN, *Council*, H. C. FULLER, W R MAXON, A A DOOLITTLE, B H SWALES, I HOFFMAN.

S F BLAKE, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. E. T. ALLEN of the Geophysical Laboratory, Carnegie Institution of Washington, left Washington in June to continue his field work on the hot springs of the Yellowstone National Park

Dr. N. H. DARTON of the U S Geological Survey has returned from Central Venezuela where he has been making geologic reconnaissance surveys for an oil company during the past six months

CHARLES V. THEIS has been appointed a Junior Geologist in the U. S. Geological Survey.

Dr. ROGER C. WELLS of the Geological Survey has accepted appointment as Associate Editor of the WASHINGTON ACADEMY OF SCIENCES to represent the Chemical Society.

The following delegates and guests of the American Geophysical Union will attend the Third General Assembly of the International Geodetic and Geophysical Union at Prague, September 3 to 10, 1927.

Delegates

Dr. LOUIS A. BAUER, Director, Department of Terrestrial Magnetism of the Carnegie Institution of Washington, accompanied by Mrs. Bauer

Dr. WILLIAM BOWIE, Chief, Division of Geodesy, U. S. Coast and Geodetic Survey, accompanied by Mrs Bowie and their adult son.

Dr. J. H. DELLINGER, Senior Physicist, Radio Section, U. S Bureau of Standards, accompanied by Mrs. Dellinger.

Commander N. H. HECK, Chief, Division of Terrestrial Magnetism and Seismology, U. S. Coast and Geodetic Survey.

Mr. W. D. LAMBERT, Mathematician, Division of Geodesy, U S. Coast and Geodetic Survey, accompanied by his sister, Miss Mary B Lambert.

Dr. R. A. MILLIKAN, Director California Institute of Technology.

Dr. HARRY FIELDING REID, Professor of Dynamic Geology, Johns Hopkins University.

Guest

Prof. L. C GRATON, Department of Geology, Harvard University, accompanied by Mrs. Graton and their adult son and adult daughter.

ELLSWORTH P. KILLIP, of the National Museum, has returned from a botanical trip to the Eastern Cordillera of Colombia The party, consisting of Mr KILLIP and ALBERT C SMITH, of New York, was sent by the National Museum, the New York Botanical Garden, the Gray Herbarium of Harvard University, and the Arnold Arboretum to obtain botanical specimens in the little-known region between Bucaramanga and the Venezuelan border. Ten paramos, between 12,000 and 15,000 feet altitude, in the vicinity of Bucaramanga, were visited, and collections were also made along the headwaters of the Orinoco and Maracaibo drainage basins. Approximately 6000 numbers were obtained in these regions, an additional thousand being collected near Cartagena and Santa Marta, on the Atlantic coast.

AGNES CHASE of the Bureau of Plant Industry has returned from ten weeks spent in the study of grasses, mostly American, in several European herbaria.

A month was spent in Geneva, where the De Candolle Herbarium, recently united with the Delessert Herbarium, is now accessible for study.

P. G. LEDIG, who had resigned from the Bureau of Standards to accept a position as observer in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, has been assigned to the staff of the magnetic observatory at Huancayo, Peru. Mr. LEDIG sailed from New York on July 7 for Lima.

W. C. PARKINSON will leave Peru on July 29 to return to Washington after having completed the work he was engaged upon as consulting magnetician at the Huancayo Observatory.

ANDREW THOMSON, Director of the Apia Observatory, arrived at Washington, July 6, to spend some time at the Weather Bureau and the Department of Terrestrial Magnetism. He will attend the meeting of the International Geodetic and Geophysical Union at Prague in September.

Obituary

GEORGE BISHOP SUDWORTH, a member of the ACADEMY, died May 10, at his home in Chevy Chase, in his 64th year. He was born at Kingston, Wisconsin, and educated at the University of Michigan. From boyhood he was a student of birds and plants. After a year of teaching, Mr. SUDWORTH came to the U. S Department of Agriculture as botanist and dendrologist in the Division of Forestry in 1888, and was chief dendrologist in the Forest Service at the time of his death He did extensive field work on the forest flora of the United States and is the author of several volumes on our trees, as well as a great number of bulletins and papers on dendrology and scientific forestry.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

Vol. 17 August 19, 1927 No 14

MATHEMATICS.—*On the analytical and graphical representation of the arithmetic, geometric and other means.*[1] C. E. Van Orstrand, U. S. Geological Survey.

The means ordinarily employed in mathematical statistics are simple functions of certain average values obtained from the equation

$$m = \frac{p_1x_1y_1 + p_2x_2y_2 + \ldots p_nx_ny_n}{p_1x_1^2 + p_2x_2^2 + \ldots p_nx_n^2} \ldots \qquad (1)$$

which represents the least square adjustment of the line, $y = mx$, through the points, x_1,y_1; x_2,y_2; ... x_ny_n whose respective weights are p_1, p_2, p_n.

In the following consideration of each special case there has been put for convenience

$$x_1 = 1, \; x_2 = 2, \qquad x_6 = 6$$

THE ARITHMETIC MEAN

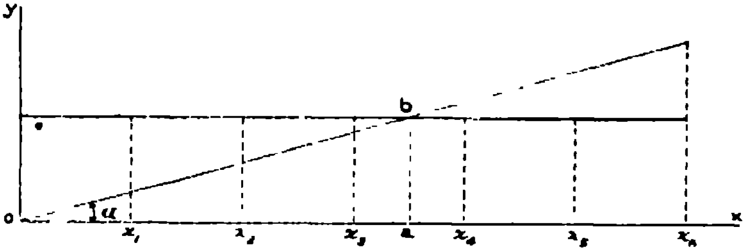

Fig. 1

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[1] Published by permission of the Director, U. S. Geological Survey. Received May 20, 1927.

Substituting in (1) the relations

$$y_1 = y_2 = \cdots = y_n = 1$$

$$p_1 = \frac{1}{x_1}; \quad p_2 = \frac{1}{x_2}; \quad \ldots\ldots \quad p_n = \frac{1}{x_n}\ .$$

we have

$$m = \tan\alpha = \frac{\Sigma y}{\Sigma x} = \frac{n}{x_1 + x_2 + \ldots\ x_n} = \frac{1}{\dfrac{x_1 + x_2 + \ldots x_n}{n}}$$

Referring to the diagram, Fig. 1, we have

$$\text{ab} = 1$$

$$\text{oa} = \frac{x_1 + x_2 + \quad .\ x_n}{n} = \text{arithmetic mean.}$$

THE GEOMETRIC MEAN

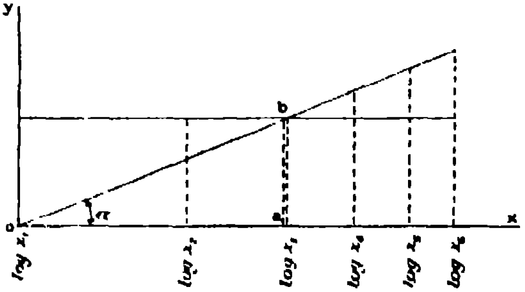

Fig. 2

Putting

$$y_1 = y_2 = \ldots = y_n = 1$$

$$p_1 = \frac{1}{\log x_1}; \quad p_2 = \frac{1}{\log x_2}; \quad \ldots \quad p_n = \frac{1}{\log x_n}$$

and writing log x for x we have

$$m = \frac{\Sigma y}{\Sigma \log x} = \frac{n}{\log x_1 + \log x_2 + \ .\ .\ \log x_n} = \frac{1}{\dfrac{\log x_1 + \log x_2 + \ \ .\ \log x_n}{n}}$$

$$ab = 1$$

$$oa = \frac{\log x_1 + \log x_2 + \ \ .\ \ \log x_n}{n} = \log \text{ (geometric mean)}$$

$$\therefore \text{ geometric mean} = e^{\overline{oa}}$$

THE HARMONIC MEAN (a)

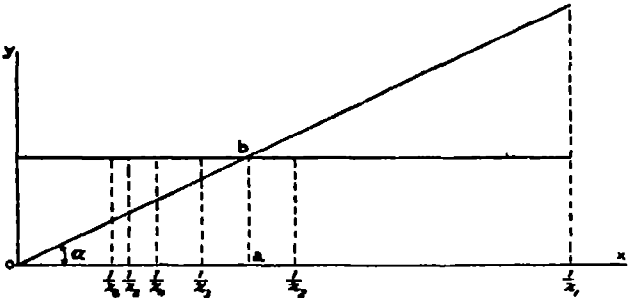

FIG 3

Replacing the abscissas by their reciprocals and putting

$$y_1 = y_2 = \ \ .\ .\ y_n = 1$$

$$p_1 = x_1;\ p_2 = x_2;\ ..\ \ p_n = x_n$$

we have

$$m = \frac{n}{\dfrac{1}{x_1} + \dfrac{1}{x_2} + \ \ .\ \dfrac{1}{x_n}} = \frac{1}{\dfrac{1}{n}\left(\dfrac{1}{x_1} + \dfrac{1}{x_2} + \ ..\ \ \dfrac{1}{x_n}\right)} = \text{harmonic mean.}$$

$$ab = 1$$

$$oa = \frac{1}{n}\left(\frac{1}{x_1} + \frac{1}{x_2} + \ \ .\ \ \frac{1}{x_n}\right) = \text{reciprocal harmonic mean.}$$

THE HARMONIC MEAN (b)

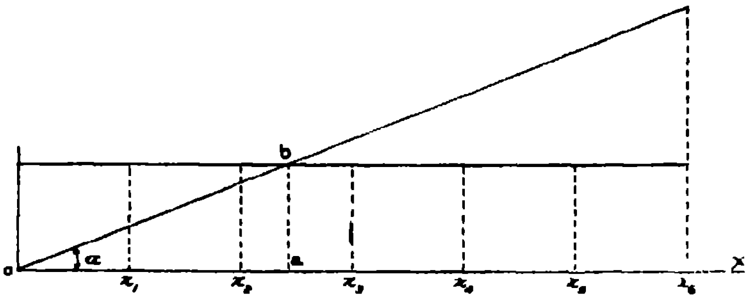

FIG. 4

Another representation of the harmonic mean is obtained from the relations

$$y_1 = y_2 = \ldots = y_n = 1$$

$$p_1 = \frac{1}{x_1^2};\ p_2 = \frac{1}{x_2^2};\ \ldots\ p_n = \frac{1}{x_n^2}$$

There results

$$m = \frac{\Sigma\left(\frac{y}{x}\right)}{n} = \frac{1}{n}\left(\frac{1}{x_1} + \frac{1}{x_2} + \quad \frac{1}{x_n}\right) = \text{reciprocal of harmonic mean.}$$

$$\text{ab} = 1$$

$$\text{oa} = \frac{1}{\frac{1}{n}\left(\frac{1}{x_1} + \frac{1}{x_2} + \ldots \frac{1}{x_n}\right)} = \text{harmonic mean.}$$

THE CONTRA-HARMONIC MEAN

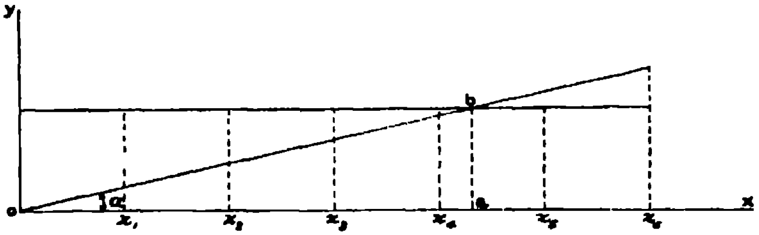

FIG 5

Put

$$y_1 = y_2 = \ldots = y_n = 1$$

$$p_1 = p_2 = \ldots = p_n = 1$$

then we have

$$m = \frac{\Sigma x}{\Sigma x^2} = \frac{1}{\dfrac{x_1^2 + x_2^2 + \quad x_n^2}{x_1 + x_2 + \quad . \; . \; x_n}}$$

$$ab = 1$$

$$oa = \frac{x_1^2 + x_2^2 + \quad . \; x_n^2}{x_1 + x_2 + \quad . \; . \; x_n} = \text{contra-harmonic mean.}$$

THE ROOT-MEAN-SQUARE

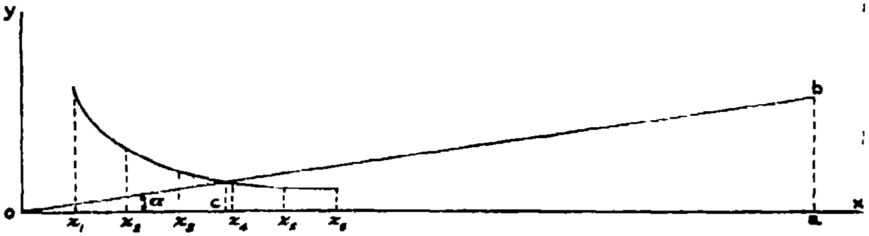

FIG 6

Put

$$y_1 = \frac{1}{x_1}; \; y_2 = \frac{1}{x_2}; \quad . \; y_n = \frac{1}{x_n}$$

$$p_1 = p_2 = \ldots = p_n = 1$$

and equation (1) becomes

$$m = \frac{n}{\Sigma x^2} = \frac{1}{\dfrac{x_1^2 + x_2^2 + \; . \; . \; x_n^2}{n}}$$

$$ab = 1$$

$$oa = \frac{\Sigma x^2}{n} = \frac{x_1^2 + x_2^2 + \quad . \; x_n^2}{n} = \text{mean square.}$$

$$\sqrt{\text{oa}} = \text{oc} = \sqrt{\frac{x_1^2 + x_2^2 + \quad x_n^2}{n}} = \text{root-mean-square.}$$

The root-mean-square is evidently the abscissa of the point of intersection of the line, $y = mx$, with the hyperbola, $xy = 1$, for we have

$$y = mx = \frac{n}{x_1^2 + x_2^2 + \ldots x_n^2}\, x = \frac{1}{x}$$

$$\therefore x = \text{oc} = \sqrt{\frac{x_1^2 + x_2^2 + \quad . \, x_n^2}{n}}.$$

If we overlook the physical requirements and base our definition on the mathematical relations only, it is evident that the definitions of harmonic mean and reciprocal harmonic mean are inconsistent—the definitions should be interchanged as each of the other means is a function of $1/m$ instead of m.

It is interesting to note that with the exception of the root-mean-square which is defined with reference to the simplest form of hyperbola, all of the means here discussed are defined with reference to the straight line, $y = a + bx$, in which $a = 1$ and $b = 0$.

Generalizing our results, we may say that certain means may be defined as the abscissa, or as a function of the abscissa of the point of intersection of the line, $y = mx$, with the curve, $y = \mathrm{f}(x)$. The value of m is determined by the method of least squares from the n points (x_1, y_1 weight p_1 $\quad$ x_n, y_n weight p_n) on the curve $y = \mathrm{f}(x)$, the abscissae (x_1, x_2 . . . x_n) of the n points being the quantities whose mean is to be determined. A further generalization of the definition consists in replacing the x coordinates by functions of these coordinates such as $\log x$.

PALEONTOLOGY.—*New species of mollusks from the Eocene of Texas.*[1] JULIA GARDNER, U. S. Geological Survey.

This paper contains descriptions and figures of 21 new species and subspecies of mollusks from the Claiborne and Wilcox groups in Texas, distributed as follows: Cook Mountain formation, 16; Lisbon formation, 1; Yegua formation, 1; Wilcox group, 3.

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[1] Published by permission of the Director, U. S. Geological Survey. Received May 12, 1927.

Family LEDIDAE

Genus LEDA Schumacher

Leda trivitate Gardner, n. sp.

Figure 5

1919. *Leda houstonia* Harris, Bull. Am. Pal 6: *pl. 23, f. 13.* Not *Leda houstonia* Harris, 1895.

Shell small, thin, rather highly polished, compact; the altitude of the shell exceeding half the latitude, broadly and quite strongly inflated. Umbonal angle very large. Umbones not conspicuous; slightly bulbous and feebly opisthogyrate, placed a little in front of the median vertical. Anterior dorsal margin more gently sloping than the posterior; anterior extremity broadly rounded; posterior extremity obtusely rostrate; base line strongly arcuate; posterior ridge obtuse and, toward the ventral margin, often ill-defined; posterior area thus delimited, narrow, lanceolate with faint traces of secondary rays, both posterior and anterior sometimes visible. External surface for the most part smooth; a microscopically fine, concentric striation usually developed toward the lateral and ventral margins; traces of radial threadlets often visible upon the ventral portion of the rostrum and, more rarely, upon the anterior ventral margin. Ligament pit minute, subumbonal, wider than it is high. Teeth strong, elevated medially, lower toward the distal extremities of each series; anterior teeth not far from ten in number, coarser than the posterior teeth which run close to fifteen. Adductor impressions relatively large, the anterior sub-circular, the posterior larger and more angular. Pallial line obscure. Inner margins entire excepting for a very fine crenulation along the rostrum.

Dimensions: Altitude, 2.5 millimeters; latitude, 4.0 millimeters; diameter, 2 1 millimeters.

Holotype.—U. S. Nat Mus Cat. No 369248.

Type locality.—Bluff on San Antonio River 4 miles south-southeast of Floresville, Wilson County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

Leda trivitate is closely allied to *Leda houstonia* Harris. It is, however, a smaller, relatively higher and more inflated species, with a less sharply defined sculpture both radial and concentric.

It is more widely distributed than *L. houstonia* and more abundant at the localities at which it occurs.

Leda jewetti Gardner, n. sp.

Figure 6

Shell small, plump, polished, the young not far from equilateral; the adults produced slightly and obtusely rostrate posteriorly. Anterior dorsal margin a little higher than the posterior; anterior lateral margin broad and broadly rounded; posterior extremity narrow, obtuse; base line strongly arcuate, constricted in front of the rostrum in the adults. Umbones full, the tips proximate and opisthogyrate, slightly anterior. Lunule and escutcheon similar, the former a little less produced, narrow, lanceolate, delimited by a ridge most elevated near the umbones. Posterior area defined by a secondary ray evanescing upon the rostrum. External surface concentrically threaded medially, the threads uniform over a symmetrical area, the sculpture abruptly disappearing a little in front of the rostrum and more gradually evanescing anteriorly. Ligament minute, sub-umbonal. Dentition vigorous, the teeth elevated and acutely Λ-shaped medially, those of the anterior series more crowded and more numerous than of the posterior. Adductor scars obscure, relatively large and well up under the dorsal margins. Pallial line obscure. Inner margins entire.

Dimensions: Altitude, 3.8 millimeters; latitude, 6.2 millimeters; semi-diameter, 1.7 millimeters.

Holotype —U. S. Nat. Mus. Cat. No. 369243.

Type locality.—8 miles south of Jewett, Leon County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of the Claiborne group).

Leda jewetti is doubtless the Texas analogue of the Mississippi species *Leda catasarca* Dall. The outlines and dimensions of the two forms are similar but the posterior area of *L catasarca* is more sharply defined; the concentric ribbing is broader and less uniform, usually less elevated and developed over a more restricted area. In *L. jewetti* the entire medial portion of the shell is threaded from the umbones to the base line, the triangular sculptured area extending from an approximately equal distance in front of and behind the umbone In *L. catasarca*, on the contrary, the sculpture is comparatively feeble over the entire anterior half of the shell, though it is continued posteriorly to a greater degree than in *L jewetti*.

Leda atakta Gardner, n sp.

Figures 7, 8

Shell rather small, plump, constricted and rostrate posteriorly. Umbones sub-central, quite full, the tips proximate and opisthogyrate. Anterior dorsal margin obliquely descending; posterior dorsal margin slightly produced and feebly concave; base line arcuate, ascending posteriorly Lunular area depressed but not well defined. Escutcheon produced for about half the distance from the umbones to the posterior ventral margin, feebly depressed; the margin elevated and clearly defined by an elongate-cordate area inclosing the escutcheon and extending from the umbones to the extremity of the rostral ray; a second ray developed anterior to the rostrum, well defined but not conspicuous; its extremity indicated at the ventral margin by a slight jog. Concentric sculpture not developed upon the umbonal area; surface away from the umbones threaded with well rounded lirae evanescent upon the anterior portion of the shell and abruptly disappearing a little in front of the secondary rostral ray; rostrum incrementally striated but not threaded. Chondrophore minute, sub-umbonal. Dentition moderately strong; the teeth in the anterior series approximately 18 in number; posterior series feebly concave, of nearly the same length as the anterior but less crowded, containing only about 15 component teeth. Adductor and pallial scars very obscure; shell reinforced by a slight thickening upon the inner surface directly in front of the rostrum.

Dimensions: Altitude, 3.5 millimeters; latitude, 6.0 millimeters; diameter, 2.6 millimeters

Holotype.—U. S. Nat. Mus Cat. No. 369241

Type locality.—Smithville, Bastrop County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

Leda atakta is a species of no striking characters but it does not conform to any of the prescribed groups. *Leda jewetti* is relatively higher, with rostral rays and with a concentric sculpture developed over a greater part of the surface. *Leda media* to which *L. atakta* is closely related is more produced and attenuated posteriorly, with a finer concentric sculpture developed upon the umbones, as well as upon the medial and ventral portions of the shell. In both species, however, the sculpture is obsolete upon the anterior portion of the shell

Family ARCIDAE

Genus BARBATIA Gray

Barbatia deusseni Gardner n. sp.

Figures 20, 21

1919. *Arca rhomboidella* Harris (part), Bull. Am. Pal 6: 51. Not *Arca rhomboidella* H. C. Lea, 1833.

Shell rather small, moderately heavy, transversely elongated, obliquely constricted mesially; basal margin parallel to the hinge; anterior lateral margin obliquely truncated; the posterior lateral margin vertically truncate, rounding into the base but angulated at the hinge Umbones prominent, inflated, overtopping the hinge line; the tips flattened, incurved, prosogyrate, and falling within the anterior third External surface closely sculptured radially, the ribs 40 in number on the type, finest and closest upon the obscure medial depression; slightly coarser and tuberculated anteriorly; coarsest and least crowded upon the obtuse posterior keel; anterior and medial ribs medially sulcate; posterior ribs entire though somewhat nodulated; a very fine, even, concentric threading visible in the interspaces and reflected in the nodulation of the ribs Cardinal area very narrow, asymmetric; area beneath and in front of the umbone smooth, area behind the umbones obliquely grooved Hinge very narrow medially, widening laterally; teeth beneath the umbones very short and vertical; short and oblique along the narrow posterior portion of the hinge, the distal teeth quite coarse and approximately parallel to the hinge. Muscle scars and pallial line obscure. Inner margins coarsely dentate

Dimensions: Altitude, 11 6 millimeters; latitude, 17.7 millimeters; semidiameter, 5.2 millimeters

Holotype.—U. S. Nat. Mus. Cat. No. 369244.

Type locality.—One mile below Collins Ferry, Burleson County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

Lea's Claiborne species, with which the Texas form has been confused, is decidedly less gibbous, more elongated transversely, and with a less uniform ribbing.

I have the pleasure of naming this form in honor of Alexander Deussen, Esq., who by his assiduous collecting has so largely increased our knowledge of the Tertiary of Texas.

Family OSTREIDAE

Genus OSTREA Linnaeus

Ostrea duvali Gardner, n. sp.

Figures 1–4

Shell of moderate dimensions for the genus, inequivalve, ovate-trigonal in outline, frequently with a large attachment area and relatively broad in consequence. Surface layer decorticated; right valve built up of overlapping concentric lamellae so that the shell thins toward the ventral margin, and would be heaviest in the umbonal area were it not for the encroachment of the ligament area; a subcutaneous radial threading on the right valve but no true radial scuplture developed; left valve fluted with narrow radials ranging in number from 20 to 25 in the narrower forms and running to 35 and 40 in the broader; obsolete on the attached surface. Ligament area large, flattened in the right valve; the medial depression in the left valve broadly U-shaped. Lateral margins of right valve finely pitted, the pitting persistent in some individuals around the entire inner margin. Adductor scars rather small, crescentic, not deeply excavated, posterior and below the median horizontal. Pedal scar obscure.

Dimensions: Right valve, altitude, 10.6 millimeters; latitude, 6.1 millimeters, semi-diameter, 2.4 millimeters Left valve of another individual; altitude, 10.5 millimeters; latitude, 6 95 millimeters; semi-diameter, 3 45 millimeters.

Cotypes.—U. S. Nat. Mus. Cat. No. 369239.

Type locality.—Austin-Elgin Ferry road, 1 mile north of Austin-Bastrop Highway, Bastrop County, Texas.

Geologic horizon.—Wilcox group, probably the Indio formation.

Ostrea duvali suggests in the sculpture characters *Ostrea crenulimarginata* Gabb and *Ostrea multilirata* Conrad. If the left valves alone were known, they would be referred without serious misgivings to *O. multilirata;* if the right valves only, they might be confused with *O. crenulimarginata* Gabb. The finer, more numerous radials of *O. duvali* serve to separate it from *O crenulimarginata*, and the absence of radials upon the right valves distinguish it from *O. multilirata*.

The exact horizon of *Ostrea duvali* is not known but it is certainly Wilcox and younger than *Ostrea multilirata* Conrad.

I have the pleasure of dedicating this species to Mr. Hugh Duval of Bastrop, Texas, to whose kindness I am indebted for the knowledge of the locality. Many visiting geologists during the past few years have profited by Mr. Duval's keen observation, intelligent interest in the country about him, and his splendid collections—the best that I have seen in the way of a local assemblage.

Occurrence.—Austin-Elgin Ferry road, 1 mile north of Austin-Bastrop Highway, Bastrop County; Caldwell Knob, Bastrop County; 1 mile northeast of New Berlin, Guadalupe County.

Family PHOLADOMYACIDAE

Genus PHOLADOMYA Sowerby

Pholadomya (clairbornesis subsp.?) harrisi Gardner, n. sp.

1919. *Pholadomya claibornensis* Harris, Bull. Am. Pal. 6: 197. *pl. 59, f.* 9. Not *Pholadomya claibornensis* Aldrich, 1886.

Shell exceedingly thin, nacreous, oblong. Trigonal in outline, expanded anteriorly; the posterior dorsal margin approximately parallel to the base; the posterior extremity very broadly rounded. Umbones full, prominent, nearly terminal, the tips incurved and in contact. Concentric folds rather coarse, strong and regular, though incremental in character; radials well developed upon the medial portion of the shell, absent upon the extreme anterior and over a slightly greater posterior area; discontinuous, inclined to be nodose at the intersection with the concentric rugae and obsolete in the interspaces. Characters of the hinge and interior not known.

Dimensions: Altitude, 22.0 millimeters; latitude, 30.0 millimeters. (Taken from drawing.)

Holotype.—Cornell University, Ithaca, New York.

Type locality.—Two miles east of Alto, Cherokee County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of the Claiborne group).

The Texas specimens have been separated from those from Alabama because of the stronger and more persistent radial sculpture and apparently coarser concentric markings. The species is poorly preserved, as a rule, and has only a meager representation so that it is difficult to determine either the constancy or the value of these differences

I have the pleasure of naming the form in honor of Prof. Gilbert D. Harris of Cornell University.

Family VERTICORDIIDAE

Genus VERTICORDIA (Searles Wood Ms) Sowerby

Verticordia satex Gardner n. sp.

Figures 22, 23

Shell highly nacreous, small, compressed, subtrigonal in outline, inequilateral. Umbones sub-central, incurved, strongly prosogyrate. Margin directly in front of the umbones deeply excavated by the false lunule. Escutcheon absent. Anterior extremity strongly arcuate; posterior dorsal and lateral margins forming a parabolic curve from the umbones to the arcuate base. Outer surface heavily corded with 14 subequal, abruptly elevated ribs radiating from the umbones in gentle curves, convex posteriorly, more widely spaced medially but with no sharp break in the spacing; interradials deeply concave and wider than the radials; entire external surface micro-granular; outer margins sharply dentate. Ligament opisthodetic, deeply inset, continued to the apices of the umbones A single, rather stout, subumbonal cardinal developed in the right valve, received in the left valve between the dorsal margin and the thickened inner margin of the lunule which functions as a denticle; posterior margin of right valve grooved to receive the bevelled margin of the left. Anterior muscle scar small, elongate, quite deeply sunken, its dorsal extremity beneath the ventral margin of the false lunule, posterior muscle scar obscure. Pallial line remote from the margin, distinctly impressed.

Dimensions: Altitude, 3.0 millimeters; latitude, 3.0 millimeters; semidiameter, 0.7 millimeter.

Holotype.—U. S. Nat. Mus. Cat. No. 369240.

Type locality.—Mosley's Ferry, Brazos River, Brazos County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

Verticordia satex is doubtless related to *Verticordia eocenensis* Langdon described from Wautubbee Hills, Clarke County, Mississippi. The Texas species is a smaller and more delicate shell, less inflated, more trigonal in outline, with a more sharply elevated radial sculpture.

Family CRASSATELLITIDAE

Genus CRASSATELLITES Krüger

Subgenus CRASSINELLA Guppy

Crassatellites (Crassinella) pteleina Gardner n. sp.

Figures 18, 19

Shell very small, quite thin, nearly equilateral, evenly inflated, roughly a sector of 90°. Umbones inconspicuous, somewhat flattened upon their summits, the tips turned slightly forward. Lunule and escutcheon coextensive with the dorsal margins, the lunule the narrower and the less produced; both of them sharply defined by the angulation of the valve and by the absence of any sculpture. Anterior dorsal margin shorter than the posterior; base arcuate. Surface smooth excepting for a somewhat exaggerated incremental sculpture, strongest upon the umbones and toward the lateral and ventral margins; an exceedingly fine radial lineation similar to that often discernible upon the recent *C lunulatus* developed in some individuals Ligament entirely internal; the ligament pit produced beneath the tips of the umbones Hinge plate minute, the dentition delicate; right anterior cardinal partially fused with the dorsal margin; posterior cardinal short, slender, cuneate; anterior dorsal margin grooved its entire length to receive the bevelled edge of the left valve; posterior dorsal margin slightly modified to function as a lateral; dentition of left valve not known but doubtless normal. Adductor scars large but obscure. Pallial line simple, distant from the ventral margin.

Dimensions: Altitude, 2.5 millimeters; latitude, 2.75 millimeters; semidiameter, 1.0 millimeter

Holotype.—Aldrich collection, Johns Hopkins University, Baltimore, Md

Type locality.—Elm Creek, Lee County, Texas.

Geologic horizon.—Yegua formation (upper part of Claiborne group).

The species is remarkable for the even inflation of the disk, and the absence of any well-defined sculpture. Nothing very close to it has been recognized.

Crassatellites (Crassinella) aldrichi Gardner n. sp.

Figures 14–17

1919. *Crassinella minor* Harris (part), Bull. Am. Pal. 6: 92.
Not *Astarte minor* Lea, 1833.

Shell minute, compressed, narrow trigonal, nearly equilateral. Umbones acute, feebly arcuate, the tips proximate, with a slight posterior inflection, nearly central in position. Dorsal margins straight, converging at an angle of not far from 90°; base line arcuate, a little more strongly upcurved anteriorly than posteriorly. Lunule and escutcheon co-extensive with the dorsal margins; escutcheon the wider of the two, and like the lunule defined not only by the angulation of the valves but also by the abrupt disappearance of the concentric sculpture. Sculpture very irregular in development, never very sharp; tips of umbones usually smooth; the rest of the shell concentrically wrinkled, the folds coarser, as a rule and less closely spaced upon the medial portion of the shell than upon the ventral, tending to flatten a little toward the margins of the lunule and the escutcheon where they abruptly disappear. Ligament entirely internal, the pit produced well beneath the umbones. Dentition delicate; anterior cardinal of right valve fused with the cardinal margin; posterior cardinal, laminar, somewhat cuneate, posterior dorsal margin bevelled to function as a lateral; anterior dorsal margin of right valve sulcate, the inner margin elevated medially; anterior cardinal of left valve elevated, laminar, the posterior cardinal very short and partially fused with the dorsal margin; margin of ligament pit elevated, simulating a tooth; anterior dorsal margin of left valve bevelled, the posterior sulcate, and the inner margin raised medially. Adductor scars relatively large Pallial line simple Inner margins not crenate

Dimensions: Right valve: altitude, 2 6 millimeters, latitude, 2.5 millimeters, semi-diameter, 0.8 millimeter; left valve: altitude, 2.4 millimeters; latitude, 2.3 millimeters; semi-diameter, 0 7 millimeter.

Cotypes —U. S. Nat. Mus. Cat No. 369249.

Type locality —4 miles southeast of Floresville, Wilson County, Texas.

Geologic horizon —Cook Mountain formation (lower part of Claiborne group).

Crassatellites (*Crassinella*) *aldrichi* is the analogue in the Texas Eocene of *Crassatellites* (*Crassinella*) of Alabama. It is a smaller species than *C. parva* Lea with a more obtuse sculpture. The sculpture is not developed upon the umbones, as a rule, while in *C. minor* Lea the fine, sharp laminae are initiated at a very early stage.

Crassatellites aldrichi is restricted in its distribution and never very abundant. I have the honor to name it for Truman H. Aldrich, Esq . long among the foremost of the Tertiary paleontologists.

Family CARDITIDAE

Genus VENERICARDIA Lamarck

Venericardia horatiana Gardner, n. sp.

Figures 28, 29

Shell rather small, thin, rudely quadrate, moderately inflated; obscurely flattened posteriorly. Umbones quite small, incurved, prosogyrate, acutely tapering, placed a little in front of the median vertical. Lunule minute, deeply impressed. Anterior end very broadly rounded; posterior dorsal margin obliquely sloping, rounding into the vertically truncate lateral extremity; base line feebly arcuate. Tips of umbones reticulately sculptured; radials, excepting on weathered specimens, restricted to the dorsal posterior portion of the shell, most closely spaced posteriorly, not developed on the extreme half or third of the shell; radials usually 20 or 21 in number, moderately elevated near the umbones and showing a slight tendency to be nodose; inter-radials near the umbones broadly U-shaped, the incrementals very fine and sharp and evenly developed in the channels but not over-riding the radials; radial sculpture away from the umbones sub-cutaneous; the inter-radials appearing as very feebly incised lines; least feeble posteriorly; a scalloped incremental sculpture showing faintly upon the ventral portion of the shell. Hinge plate moderately heavy. Ligament external, the area narrow and much produced. Dentition normal; anterior cardinal of right valve nearly obsolete; medial cardinal heavy, asymmetrically cuneate, posteriorly produced, feebly striated transversely; posterior right cardinal slender, elevated; anterior left cardinal short, stout; posterior cardinal much produced, relatively slender, the inner surface of the anterior and both the lateral surfaces of the posterior cardinal transversely striated. Characters of interior sharply defined by the slight thickening of the shell over the surface of the adherent mantle. Adductor scars very distinct, the anterior rudely reniform, the posterior semi-elliptical; pedal scar small but deeply impressed, directly dorsal to the anterior adductor. Pallial line simple, rather far removed from the ventral margin; inner margins strongly crenate.

Dimensions: Altitude, 25.0 millimeters; latitude, 27.0 millimeters; semi-diameter, 9.0 millimeters.

Holotype.—U. S. Nat. Mus. Cat. No. 369238.

Type locality.—1½ miles west of Sabinetown, Sabine County, Texas.

Geologic horizon.—Wilcox formation.

Venericardia horatiana is remarkable for the quadrate outline, and the character of the sculpture. Beneath the outer shell layer, the radials are angular and persistent to the ventral margin; but in perfectly preserved specimens, they are almost entirely concealed by the epidermal veil. This epidermis is produced, at the lower margin, a trifle beyond the layers beneath and the scalloping of this thin edge is remarkably sharp.

Though obviously of the general group of *V. planicosta*, this species is not approached very closely by any others.

Venericardia trapaquara subsp. **texalana** Gardner, n. subsp.

Figures 24–27

1919. *Venericardia trapaquara* Harris (part), Bull. Am. Pal. **6**: 81. *pl 30, f. 7.*

Shell of only moderate dimensions, rather thin, rudely trigonal to quadrate in outline, moderately inflated. Umbones gibbous, the tips incurved and prosogyrate, anterior in position. Lunule minute, depressed, sharply delimited. Anterior extremity strongly bowed in front of the lunule; posterior dorsal margin gently sloping, rounding broadly into the vertically truncate lateral margin; base line feebly arcuate. External surface sculptured with 20 to 22 obscurely terraced radials, each crowned with a narrow, sharply serrate cord; inter-radial channels broadly U-shaped, sharply delimited; microscopically sculptured by the down-curved incrementals. Ligament and dental characters normal. Adductor scars less conspicuous than in the heavier forms. Ventral and lateral margins strongly serrate.

Dimensions. Right valve: altitude, 17.0 millimeters: latitude, 16.0 millimeters; semi-diameter, 7.5 millimeters; left valve; altitude, 17.0 millimeters; latitude, 16.5 millimeters; semi-diameter, 6.65 millimeters.

Holotype.—Academy Natural Sciences, Philadelphia, Pa.

Type locality.—Black Shoals, Brazos River, Texas.

Geologic horizon.—Cook Mountain formation (lower part of the Claiborne group).

This subspecies is remarkable for the relatively small number of ribs, and its sculpture is similar to that of *V. natchitoches* Harris, though the umbones are much lower. More perfect material may prove the subspecies to be deserving of specific rank.

Forms from St. Augustine, obviously of this same group, are more compressed and develop only 16 or 17 radials. Juveniles from the environs of Sabinetown are apparently referable to this subspecies though they are slightly more compressed than those from the type locality.

Subgenus PLEUROMERIS Conrad

Venericardia (Pleuromeris) leonensis Gardner, n. sp.

Figures 38, 39

Shell minute, solid, ovate-trigonal in outline, moderately inflated. Umbones broadly rounded, the tips proximate and nearly central; the smooth embryonic shell usually retained. Lunule relatively large, much depressed, sharply delimited. Dorsal margins converging at an angle of not far from 45°; anterior extremity bowed slightly in front of the lunule, posterior and ventral margins broadly rounded. External surface strongly fluted by the radials; radials 14 or 15 in number, as a rule, minutely nodose, increasingly elevated ventrally; inter-radials broadly U-shaped, microscopically striated by the incrementals, wider toward the ventral margin than the radials. Ligament external, opisthodetic, lodged in a narrow groove, about one-fourth as long as the posterior dorsal margin. Dentition rather delicate for so solid a shell; anterior right cardinal nearly obsolete; medial cardinal asymmetrically cuneate, much produced, posterior right cardinal obsolete; right posterior dorsal margin modified to function as a lateral, left anterior cardinal short, deltoid; left posterior cardinal relatively slender, produced parallel to the dorsal margin, separated from the cardinal by a deep trigonal sub-umbonal socket; a narrow pocket in the posterior dorsal margin to receive the modified dorsal margin of the right valve; anterior dorsal margin near the extremity of the lunule slightly modified and received in a corresponding groove in the right valve. Adductor scars relatively large. Pallial line simple. Inner margins coarsely crenate.

Dimensions: Altitude, 2.2 millimeters; latitude, 2.0 millimeters; semi-diameter, 1.0 millimeters.

Holotype.—U. S. Nat. Mus. Cat. No. 369247.

Type locality.—8 miles south of Jewett, Leon County, Texas

Geologic horizon.—Cook Mountain formation (lower part of the Claiborne group).

Venericardia leonensis is smaller than *Venericardia parva* Lea and the ribs are less numerous. *V. parva symmetrica* Dall is quite similar in outline though more compressed. If I have read the description and figure of *V.*

tortidens Harris correctly, it is very close to *leonensis*, but thinner shelled and less trigonal in outline.

Venericardia leonensis is known only from the type locality.

Family CHAMIDAE

Genus PSEUDOCHAMA Odhner

Pseudochama harrisi Gardner, n. sp.

Figures 43, 44

1919. *Chama monroensis* Harris, Bull Am. Pal. **6**: 130. *pl 41, f. 2–4.* Not *Chama monroensis* Aldrich, 1903.

Shell small, moderately heavy, rudely circular in outline; right valve evenly but not strongly inflated, the left attached valve much deeper Umbones twisted forward, conspicuously so in the left valve; the nepionic characters not preserved. Lunule and escutcheon not defined. External surface of right valve sculptured with crowded lamellae, their free edges produced into spines, usually finer and longer upon the anterior portion of the shell; left valve not well preserved, apparently much more distantly sculptured. Ligament marginal, lodged in a deep groove produced to the tips of the umbones Dentition rude; the prominent flattened subumbonal process in the left valve received between amorphous corrugated ridges in the right. Muscle scars large and prominent, the anterior elongated. Pallial line entire. Inner margins crenate.

Dimensions: Right valve: altitude, 14.5 millimeters; latitude, 16.5 millimeters; diameter, 6.0 millimeters.

Holotype —U S. Nat Mus. Cat No 139451.

Type locality —8 miles west of Enterprise, Clarke Co , Mississippi

Geologic horizon.—Lisbon formation (lower part of Claiborne group)

In sculptural characters, the species is much nearer to *P. mississippiensis* (Conrad) than it is to *P monroensis* (Aldrich) The Vicksburg form, however, is more closely and strongly spinose than any of the lower Claiborne Eocene forms under observation.

I have the pleasure of naming the form in honor of Prof Gilbert D. Harris of Cornell University, who was the first to indicate the peculiarities of this species

Family LUCINIDAE

Genus PHACOIDES Blainville

Subgenus PARVILUCINA Dall

Phacoides (Parvilucina) sabelli Gardner, n. sp.

Figures 10–13

Shell small, solid, moderately inflated, inequilateral. Umbones small but well rounded, the tips acute and directed forward; prominent by reason of their elevation, nearly central in position. Lunule rather large, abruptly depressed, probably broader and more sharply defined in the left valve than in the right. Escutcheon exceedingly narrow. Dorsal margin excavated at the lunule; anterior lateral margin broadly rounded or even obtusely angulated; posterior dorsal margin obliquely sloping, the lateral margin vertically truncate; base line strongly arcuate, often obscurely angulated posteriorly; posterior area flattened or even a little concave, defined by an obtuse keel running from the umbones to the posterior ventral margin; a shallow groove sometimes discernible near the margin. External surface smooth excepting for an incremental sculpture; and, in exceptional individuals, an exceedingly fine radial lineation. Ligament marginal, inset, the groove short, moderately deep, directed backward from the tips of the umbones. Dentition rather vigorous for so small a shell; anterior cardinal of right valve fused with the dorsal margin; posterior cardinal deltoid; anterior cardinal of left valve broader and more elevated than the posterior, separated from it by a trigonal pit for the reception of the right posterior cardinal; right laterals short, rather stout, conic, with a groove between them and the dorsal margins; receiving pockets of left valve correspondingly deep, their inner margins elevated. Adductor scars strongly impressed, the anterior reniform, the posterior irregular in outline Pallial line entire; surface thickened and somewhat punctate over the area of the attached mantle. Inner margins crenate.

Dimensions: Right valve, altitude, 2.8 millimeters; latitude, 2.7 millimeters; diameter, 1.0 millimeter. Left valve: altitude, 2.5 millimeters; latitude, 2.5 millimeters; diameter, 1.0 millimeter.

Cotypes.—U. S. Nat. Mus. Cat. No 369245.

Type locality.—1½ miles west of Sabinetown, Sabine County, Texas.

Geologic horizon.—Wilcox formation.

Phacoides sabelli is remarkable for the absence of any sculpture. It is restricted in its known distribution to the type locality.

Family DIPLODONTIDAE

Genus DIPLODONTA Bronn

Diplodonta satex Gardner, n sp

Figures 34, 35

Shell small, rather compressed, rudely quadrate in outline. Umbones full but narrow, acute and feebly prosogyrate at their tips and overtopping the dorsal margins a little behind the median vertical. Anterior dorsal margin more produced than the posterior, the anterior extremity obtusely truncate vertically; the posterior, obliquely truncate; base line broadly arcuate. Lunule and escutcheon not developed. External surface smooth excepting for a quite sharp concentric grooving restricted in some individuals to the anterior portion of the shell, in others developed upon the posterior as well. Ligament marginal, opisthodetic. Hinge apparently normal, though known only from the left valve, left anterior cardinal bifid, the posterior short and laminar, fused with the dorsal margin. Adductor scars and pallial line obscure. Inner margins beveled.

Dimensions: Altitude, 7.2 millimeters; latitude, 7.0 millimeters; semidiameter, 2.5 millimeters.

Holotype.—U. S. Nat. Mus. Cat. No. 369234.

Type locality.—Three-fourths mile south of Elkhart, Anderson County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

The angular outline is perhaps the most characteristic feature of this species. It is rather widely distributed in Anderson and Houston Counties but it has not been recognized elsewhere.

Family LEPTONIDAE

Genus BORNIA Philippi

Bornia zapataensis Gardner, n. sp.

Figure 9

Shell small, thin, approximating a low isosceles triangle, slightly depressed medially; apical angle about 110°. Posterior dorsal margin slightly higher than the anterior; lateral margins quite sharply rounded, base line nearly straight. Lunule and escutcheon not defined. External surface radially grooved, the radii inclined away from the median vertical, leaving a small medial arc devoid of radial sculpture; radials sufficiently strong upon the anterior and posterior areas to flute the inner surface; a microscopically fine concentric striation developed over the entire disk. Interior filled with a hard matrix concealing the characters of the hinge and adductor and pallial scars.

Dimensions: Altitude, 5.0 millimeters; latitude, 6.5 millimeters.

Holotype.—U. S. Nat. Mus. Cat. No. 369237.

Type locality.—3 miles southeast of Zapata, Zapata County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

Bornia zapataensis is the analogue in the Cook Mountain in Texas of *Bornia isoceles* in the McBean formation in Georgia, and *Bornia scintillata* Dall in the Gosport sand. The sculpture of the Texas species approaches more closely to that of *B. scintillata* but it is neither so fine nor so sharp and covers a greater portion of the surface.

The type is unique.

Family TELLINIDAE

Genus TELLINA Linnaeus

Tellina makelloides Gardner, n. sp.

Figures 41, 42

Shell very thin and fragile, about twice as broad as it is high; anterior portion much produced and evenly rounded; posterior end very short and obscurely rostrate. Umbones small, rising but little above the dorsal margin, strongly posterior, being only about half as far from the posterior extremity as they are from the anterior. Tips of umbones acute and inclined to be opisthogyrate. Posterior dorsal margin more steeply declining than the anterior; base line feebly arcuate; an inconspicuous but well defined fold, uniform in development from the umbones to the lower rostral angle. External surface smooth excepting for incrementals, strongest toward the ventral margin and, particularly, upon the rostral area. Ligament external, opisthodetic, the area linear, lanceolate, and extending for about half the length of the posterior dorsal margin. Hinge characters unknown. Adductor scars very obscure, as might be expected in so thin a shell. Rostral fold indicated on the casts by a rather sharp ridge. Pallial sinus not observed.

Dimensions: Altitude, 14.5 millimeters; latitude, 28.5 millimeters; diameter, 5.2 millimeters.

Holotype.—U. S. Nat. Mus. Cat. No. 369246.

Type locality.—Three-fourths mile south of Elkhart, Anderson County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

The type is a partially calcified cast with portions of the shell still adhering. The maximum diameter is at some little distance in front of the beaks. *Tellina cynoglossula* of the Claiborne is similar in outline but is smaller and more strongly sculptured concentrically.

The species is restricted in its known distribution to the environs of the type locality.

Family CORBULIDAE

Genus CORBULA Bruguière

Subgenus CARYOCORBULA Gardner

Corbula (Caryocorbula) engonatoides Gardner, n. sp.

Figures 30, 31

Shell small, the right valve slightly larger than the left, notably compressed, rather solid, rudely rectangular in outline; rostrate posteriorly, the rostrum acutely angular, sharply pinched and slightly produced at the extremity; area between the rostrum and the raised margin of the escutcheon concave. Umbones low, somewhat anterior in position, flattened upon their summits, incurved and prosogyrate, the umbo of the right valve slightly in advance of that of the left. Lunule not differentiated. Escutcheon well defined both by the raised margin and the sharp change in the direction of the incrementals, wider in the right valve than in the left. Dorsal margins gently sloping; anterior extremity well rounded, the posterior extremity obliquely truncate between the keels; base line nearly horizontal, feebly constricted in front of the produced posterior keel. External sculpture absent or very feeble upon the dorsal portion of the shell, developed upon the medial and ventral portions in the form of very heavy concentric folds, often with a fine secondary concentric striation; concentric sculpture very strong on crossing the keel, continuing across it to the margin of the escutcheon, becoming laminar toward the ventral margin, and reduced to incrementals upon the escutcheon. Ventral margin of right valve incurved and overlapping the left. Ligament very short, inset, opisthodetic. Hinge normal; the single cardinal in the right valve moderately stout, conical, received in a correspondingly deep-subumbonal pit in the left valve; a dentate process developed behind the ligament support of the left valve but no true teeth. Interior more or less thickened in the adults. Muscle scars prominent. Pallial line distinct, obscurely truncate posteriorly but not sinuated.

Dimensions: Right valve: altitude, 5 3 millimeters; latitude, 8 5 millimeter; diameter, 2.4 millimeters; left valve: altitude, 4.5 millimeters; latitude, 7.5 millimeters; diameter, 2.5 millimeters.

Cotypes.—U. S. Nat. Mus. Cat. No. 369250.

Type locality.—Smithville, Bastrop County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of the Claiborne group).

Corbula engonatoides is present in the lower part of the Claiborne group of Wautubbee, Mississippi, and has been confused with *C. engonata* Conrad, a Vicksburg species. The earlier form has a much more decided sculpture. The keel of *C. engonata* is distinct but it is not acute. In *C. engonatoides* it is not only acute, but, toward the ventral margin, sharply pinched. Directly in front of the keel, in the adult, there is a slight constriction of the basal margin while the area behind it is decidedly concave. Neither the basal constriction nor the posterior depression have been observed in the Vicksburg form. The concentric sculpture, as a rule, is initiated later in *C. engonatoides* and is more pronounced. The very faint radial sculpture of the *C. barratiana* type which is usually discernible behind the keel of *C. engonata* has not been detected upon its progenitor.

Corbula (Caryocorbula) augustae Gardner, n. sp.

Figures 32, 33

Shell small and very fragile, strongly inequivalve, the right valve much higher than the left and overlapping it ventrally and posteriorly. Right valve elevated trigonal in outline; the left, transversely ovate; right valve acutely rostrate posteriorly; a secondary keel developed at the margin of the escutcheon, the area between them depressed. Prodissoconch smooth and thick, capping the umbones as in *C. texana* Gabb. Umbones set a little in front of the median vertical, the right much more elevated than the left. Lunule not defined Escutcheon smooth and rather narrow, produced the length of the dorsal margin. Anterior end well rounded from the umbones to the base; posterior extremity in right valve vertically truncate, acutely rounded in the left; base line arcuate External surface of right valve concentrically furrowed from the prodissoconch to the ventral margin, the rugae overriding the keel and persisting to the margin of the escutcheon, though with diminished strength; concentric furrows upon left valve, coarser and fewer in number, weakening toward the anterior and posterior dorsal margins. Ligament short, inset; the support in the right valve relatively prominent. Right cardinal slender, a shallow groove near the ventral margin of the right valve for the reception of the edge of the left. Muscle scars not conspicuous Pallial line entire, obscure.

Dimensions: Right valve. altitude, 6.0 millimeters; latitude, 7.0 millimeters; diameter, 3.0 millimeters. Left valve: altitude, 4.5 millimeters; latitude, 5.7 millimeters; diameter, 2.0 millimeters.

Cotypes---U. S. Nat. Mus. Cat. No. 369242.

Type locality --Augusta, Houston County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of Claiborne group).

The right valve strongly suggests a delicate *C smithvillensis* Harris but the left valve with its coarse concentric sculpture is quite distinct from the high, inflated, feebly sculptured left valve of Harris's species.

Family RINGICULIDAE

Genus RINGICULA Deshayes

Ringicula trapaquara subsp. **deusseni** Gardner, n. subsp.

Figure 40

Shell small, solid, rather squat; the aperture a little more than half the altitude of the entire shell. Whorls approximately five in number; those of the conch and protoconch not sharply differentiated; initial turn largely submerged, the succeeding volution becoming gradually higher and more inflated; beginning of conch probably indicated by the narrow posterior tabulation introduced near the opening of the third whorl; whorls of spire trapezoidal in outline, the body broadly rounded. Surface sculptured with a relatively broad and deep sulcus near the posterior suture and nine or ten lineal sulci upon the body; area directly in front of the posterior sulcus smooth. Aperture oblique, constricted behind; peristome heavily calloused; outer lip slightly patulous, terminal varix wide and heavy, continuous with the parietal wash both anteriorly and posteriorly, serrate excepting along the margins of the siphonal exits. Columellar folds heavy, three in number; the posterior, posteriorly inclined, placed directly behind the abrupt constriction of the body, the medial nearly horizontal and very close to the marginal anterior plait; both the incurrent and excurrent siphonal notches rather broad and deep.

Dimensions: Altitude, 2.5 millimeters; maximum diameter, 1.6 millimeters.

Holotype.—U. S. Nat. Mus. Cat. No. 369236.

Type locality.—4 miles southeast of Floresville, Wilson County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of the Claiborne group).

The subspecies *deussení* differs from *Ringicula trapaquara*, strict sense, in the absence of spiral sculpture over the posterior portion of the body. The sulci are often not developed, at least upon the early whorls of the spire, in *R. trapaquara* s. s. but in the subspecies this character persists to the adult stage. The subspecies has been confused with *Ringicula biplicata* Lea, a similarly sculptured form but more slender and decidedly less calloused about the aperture.

Family LIMNAEIDAE

Genus PLANORBIS Müller

Planorbis andersoni Gardner, n. sp.

Figures 36, 37

Shell small, exceedingly thin, discoidal, depressed on the umbilical, and to a lesser degree, on the apical surface. Whorls five in number, the two earliest included in the protoconch; first whorl of conch constricted at its opening and depressed below the plane of the protoconch, later whorls increasing rather rapidly in diameter and altitude; body relatively high, broadly rounded along the periphery, obtusely rostrate on both the apical and umbilical surfaces. Surface sculpture not developed. Aperture reniform, adnate to the body wall upon the inner surface; less produced and more sharply rounded anteriorly than posteriorly. Umbilical surface funnel-shaped and somewhat scalariform, revealing all of the obtusely carinated posterior extremities of the component whorls.

Dimensions: Altitude, 1.0 millimeter; maximum latitude, 2.2 millimeters; latitude, at right angles to maximum latitude, 2.0 millimeters.

Holotype.—U. S. Nat. Mus. Cat. No. 369235

Type locality.—Three-fourths of a mile south of Elkhart, Anderson County, Texas.

Geologic horizon.—Cook Mountain formation (lower part of the Claiborne group).

This fresh-water genus has not been previously reported from the Eocene of Texas. It is fairly common at the single locality at which it is represented.

ILLUSTRATIONS

Figures 1–4. *Ostrea duvali* Gardner, n. sp. (p. 366).

1. Interior of left valve (cotype); altitude, 10.5 millimeters; latitude, 6.95 millimeters
2. Interior of right valve (cotype); altitude 10.6 millimeters; latitude, 6.1 millimeters.
3. Exterior of right valve (cotype); altitude, 10 6 millimeters; latitude, 6 1 millimeters.
4. Exterior of left valve (cotype); altitude, 10 5 millimeters; latitude, 6.95 millimeters.

Figure 5. *Leda trivitata* Gardner, n. sp (p. 363).

Dorsal view of double valves (type); latitude, 4.0 millimeters; diameter, 2 1 millimeters

Figure 6 *Leda jewetti* Gardner, n. sp. (p 363).

Exterior of right valve; altitude, 3.8 millimeters; latitude, 6.2 millimeters.

Figures 7, 8 *Leda atakta* Gardner, n sp. (p. 364).

7. Exterior of left valve (type); altitude, 3.5 millimeters; latitude, 6 0 millimeters.
8. Dorsal view of double valves (type), diameter, 2 6 millimeters.

Figure 9. *Bornia zapataensis* Gardner, n sp (p 374).

Exterior of right valve (type); altitude, 5.0 millimeters; latitude, 6.5 millimeters.

Figures 10–13. *Phacoides (Parvilucina) sabelli* Gardner, n sp. (p. 372).

10. Interior of left valve (cotype); altitude, 2.5 millimeters; latitude, 2.5 millimeters.
11. Exterior of right valve (cotype); altitude, 2.8 millimeters; latitude, 2.7 millimeters.
12. Interior of right valve (cotype); altitude, 2.8 millimeters; latitude, 2.7 millimeters.
13. Exterior of left valve (cotype); altitude, 2 5 millimeters; latitude, 2.5 millimeters

Figures 14–17. *Crassatellites (Crassinella) aldrichi* Gardner, n sp (p 368)

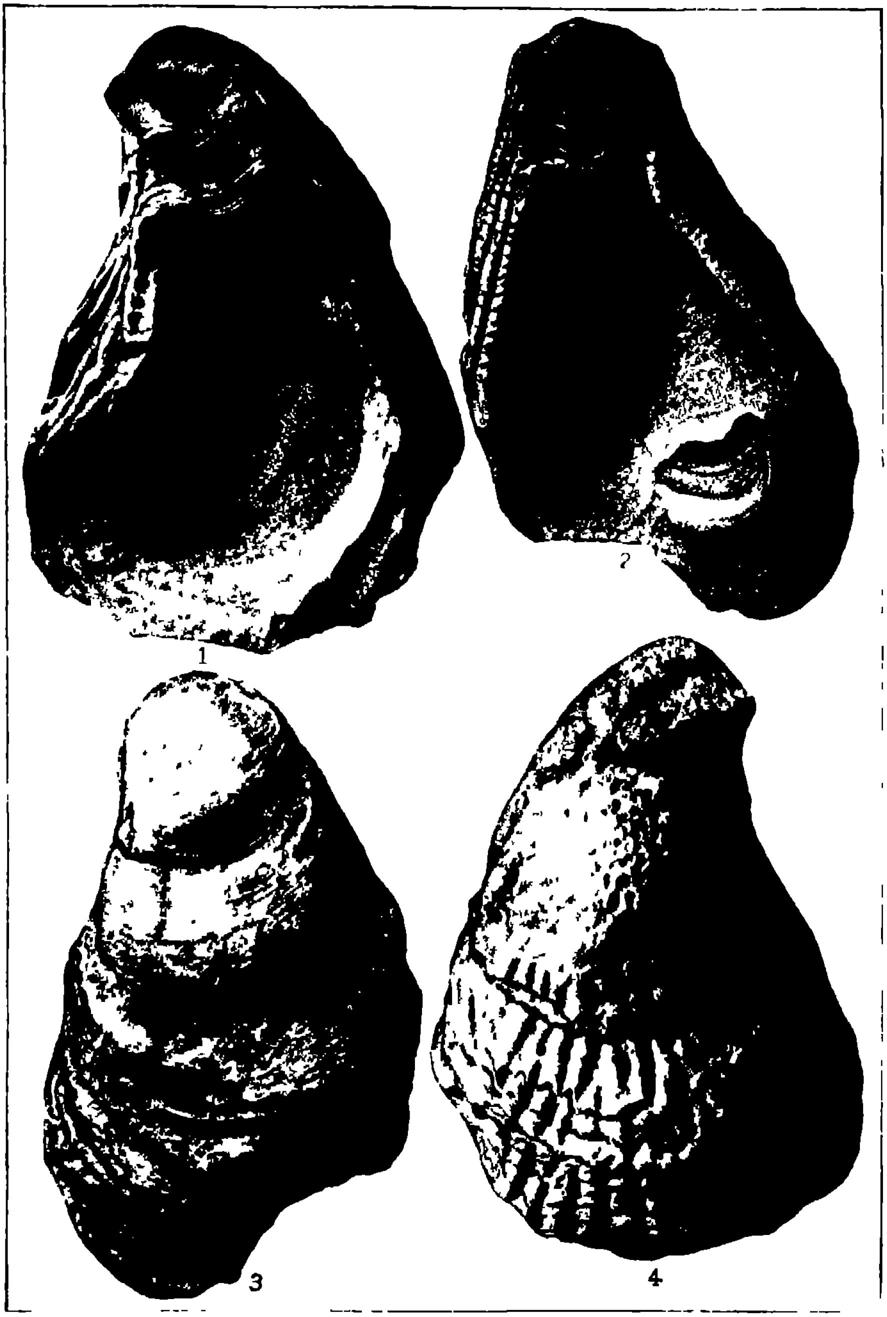
14. Interior of right valve (cotype); altitude, 2 6 millimeters; latitude, 2.5 millimeters
15. Exterior of right valve (cotype); altitude, 2 6 millimeters; latitude, 2 5 millimeters.
16. Interior of left valve (cotype); altitude, 2 4 millimeters; latitude, 2.3 millimeters
17. Exterior of left valve (cotype); altitude, 2.4 millimeters; latitude, 2 3 millimeters

Figures 18,19. *Crassatellites (Crassinella) pteleina* Gardner, n. sp. (p. 368).

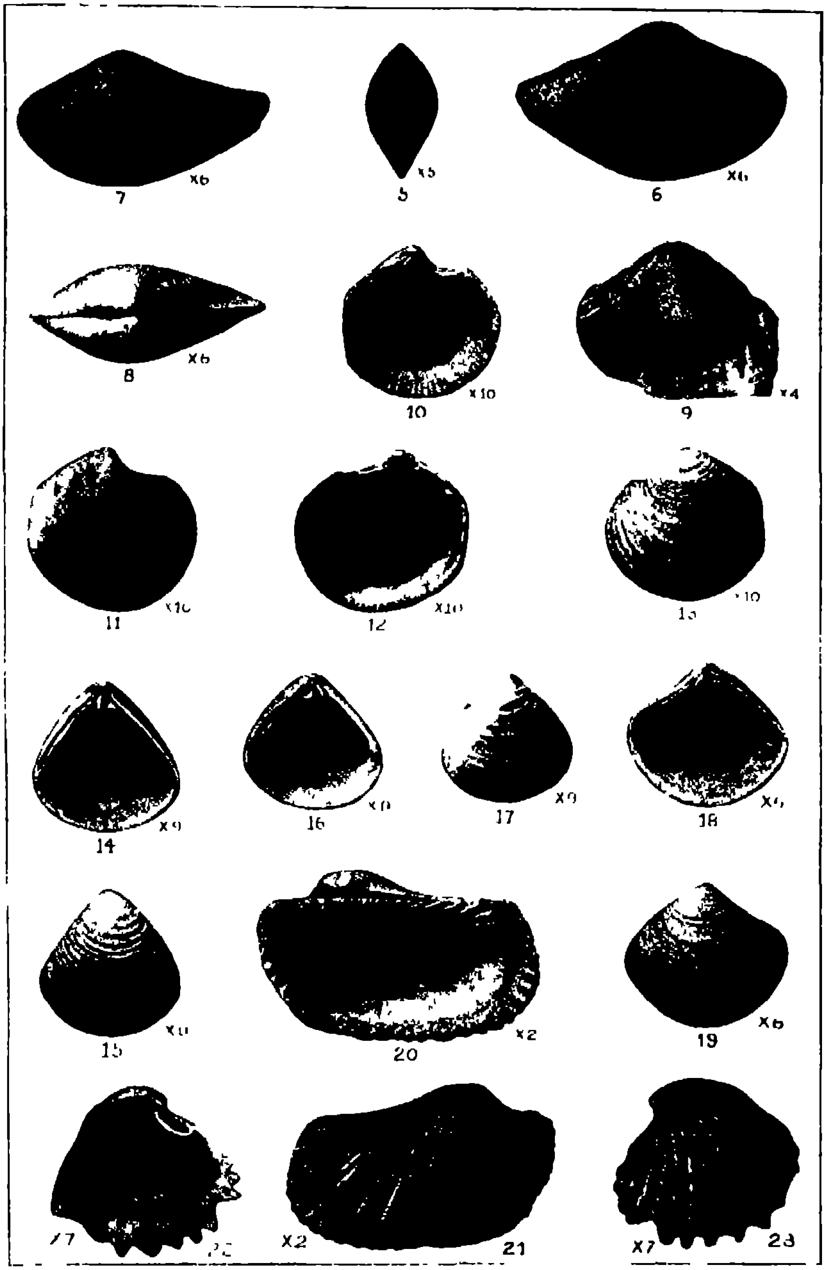
18. Interior of right valve (type); altitude, 2.5 millimeters; latitude, 2 75 millimeters.
19. Exterior of right valve (type); altitude, 2.5 millimeters; latitude, 2 75 millimeters.

Figures 20, 21. *Barbatia deusseni* Gardner, n. sp. (p 365).

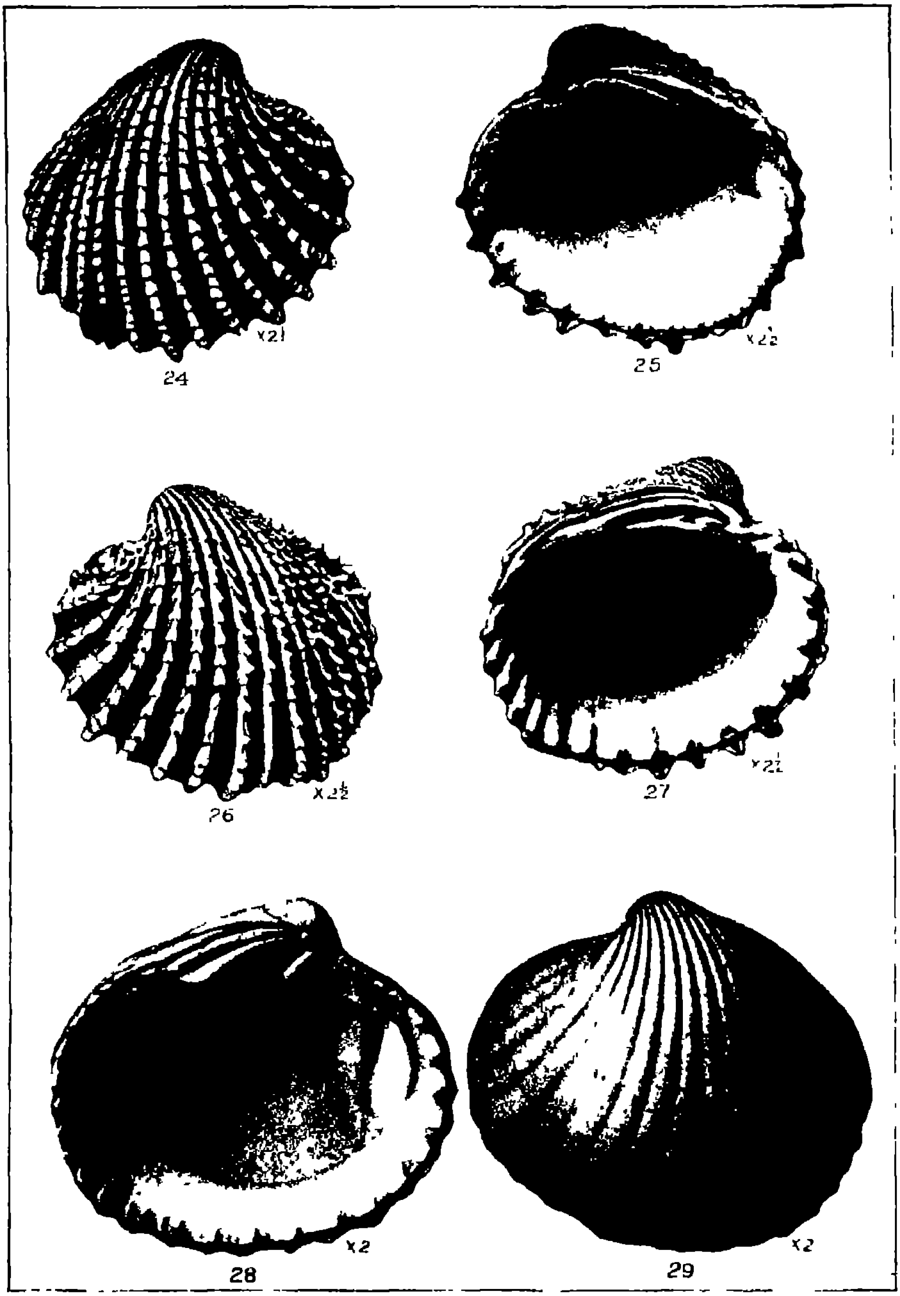
20. Interior of right valve (type); altitude, 11.6 millimeters; latitude, 17 7 millimeters.
21. Exterior of right valve (type); altitude, 11 6 millimeters; latitude, 17.7 millimeters.



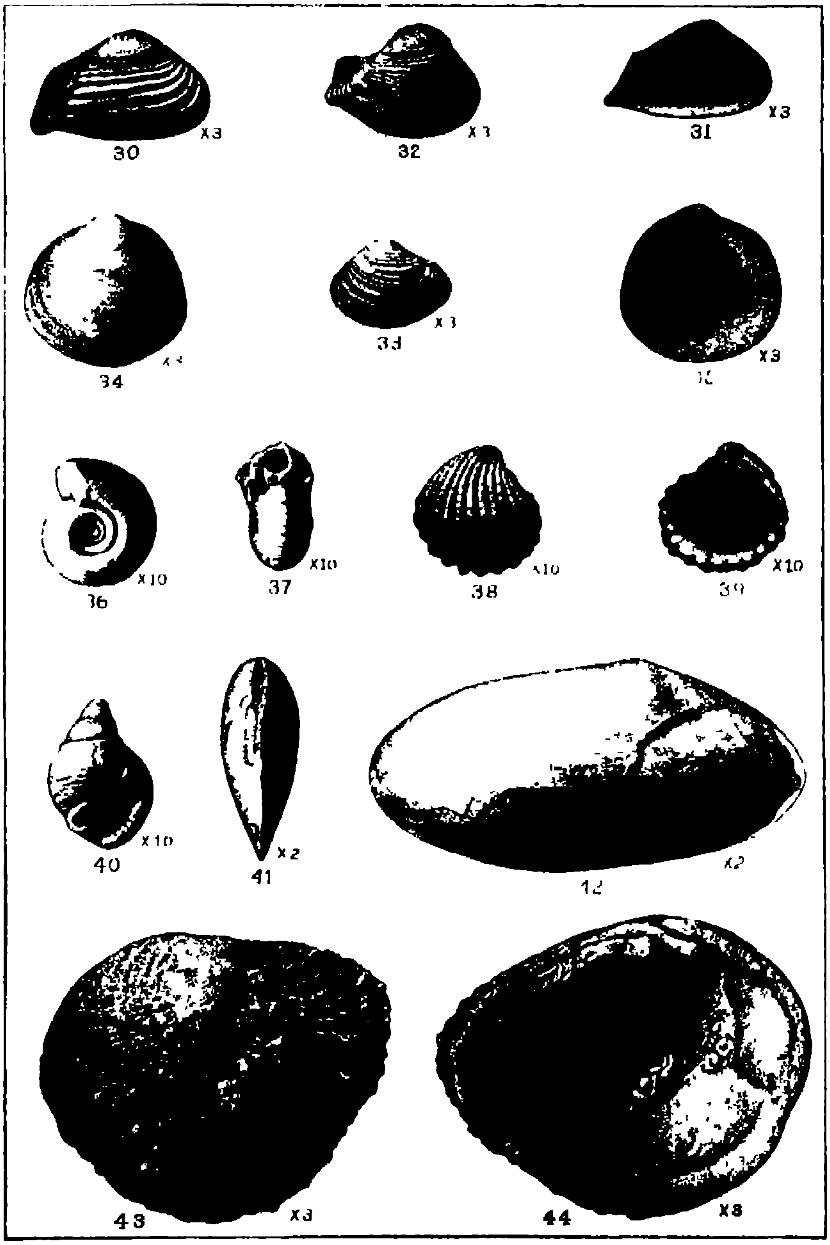
Figures 1–4, *Ostrea duvali*



Figures 5–23. 5, *Leda trinitate*, 6, *L. jewetti*, 7, 8, *L. atakta*, 9, *Bornia zapatalensis*, 10–13, *Phacoides* (*Parvilucina*) *sabelli*, 14–17, *Crassatellites* (*Crassinella*) *aldrichi*, 18, 19, *C. pteleina*, 20, 21, *Barbatia dousseni*, 22, 23, *Verticordia salei*



Figures 24–29. 24–27, *Venericardia trapaquara* subsp. *texalana*. 28, 29, *V. horatiana*



Figures 30–44 30, 31, *Corbula* (*Caryocorbula*) *engonatoides*, 32, 33, *C. augustae*, 34, 35, *Diplodonta satex*, 36, 37, *Planorbis andersoni*, 38, 39, *Venericardia* (*Pleuromeris*) *leonensis*, 40, *Ringicula trapaquara* subsp. *deusseni*, 41, 42, *Tellina makelloides*, 43, 44, *Pseudochama harrisi*

Figures 22, 23. *Verticordia salex* Gardner, n. sp. (p 367).

22. Interior of left valve (type); altitude, 3 0 millimeters; latitude, 3.0 millimeters.

23. Exterior of left valve (type); altitude, 3 0 millimeters; latitude, 3.0 millimeters.

Figures 24–27. *Venericardia trapaquara* subsp *texalana* Gardner, n subsp. (p. 370)

24. Exterior of right valve (cotype); altitude, 17.0 millimeters; latitude, 16.0 millimeters.

25. Interior of right valve (cotype); altitude, 17 0 millimeters; latitude, 16 0 millimeters.

26. Exterior of left valve (cotype); altitude, 17.0 millimeters; latitude, 16 5 millimeters.

27. Interior of left valve (cotype); altitude, 17.0 millimeters; latitude, 16.5 millimeters.

Figures 28, 29 *Venericardia horatiana* Gardner, n sp (p 369)

28. Interior of left valve (type); altitude, 25.0 millimeters; latitude, 27 0 millimeters.

29 Exterior of left valve (type); altitude, 25.0 millimeters; latitude, 27 0 millimeters.

Figures 30, 31 *Corbula* (*Caryocorbula*) *engonatoides* Gardner, n sp. (p 375)

30. Exterior of right valve (cotype); altitude, 5 3 millimeters; latitude, 8.5 millimeters.

31. Interior of left valve (cotype); altitude, 4.5 millimeters; latitude, 7 5 millimeters.

Figures 32, 33. *Corbula* (*Caryocorbula*) *augustae* Gardner, n. sp. (p. 376).

32 Exterior of right valve (cotype); altitude, 6.0 millimeters; latitude, 7 0 millimeters

33. Exterior of left valve (cotype); altitude, 4 5 millimeters; latitude, 5 7 millimeters.

Figures 34, 35. *Diplodonta salex* Gardner, n. sp (p 373).

34. Exterior of left valve (type); altitude, 7 2 millimeters; latitude, 7 0 millimeters

35. Interior of left valve (type); altitude, 7 2 millimeters; latitude, 7 0 millimeters

Figures 36, 37 *Planorbis andersoni* Gardner, n. sp. (p 377).

36 Umbilical view (type); maximum diameter, 2.2 millimeters; diameter at right angles to maximum diameter, 2.0 millimeters.

37. Apertural view (type); altitude, 1 0 millimeter.

Figures 38, 39 *Venericardia* (*Pleuromeris*) *leonensis* Gardner, n. sp (p 371)

38. Exterior of right valve (type); altitude, 2 2 millimeters; latitude, 2 0 millimeters.

39. Interior of right valve (type); altitude, 2 2 millimeters; latitude, 2.0 millimeters.

Figure 40 *Ringicula trapaquara* subsp *deussenі* Gardner, n subsp (p 376).

Apertural view (type); altitude, 2.5 millimeters; diameter, 1 6 millimeters

Figures 41, 42. *Tellina makelloides* Gardner, n sp. (p 374)

41. Posterior view of double valves (type); diameter, 5.2 millimeters.

42. Exterior of left valve (type); altitude, 14.5 millimeters; latitude, 28.5 millimeters.

Figures 43, 44. *Pseudochama harrisi* Gardner, n. sp (p 372)

43. Exterior of right valve (type); altitude, 14 5 millimeters; latitude, 16 5 millimeters

44. Interior of right valve (type); altitude, 14.5 millimeters; latitude, 16.5 millimeters.

SCIENTIFIC NOTES AND NEWS

David White, who has been serving as Chairman of the Division of Geology and Geography of the National Research Council for the past three years, has returned to his former position in the U. S. Geological Survey.

E. O. Ulrich, of the U. S. Geological Survey, sailed for England late in June and will spend about six weeks in Europe.

Eugene Stebinger, formerly geologist in the U. S. Geological Survey and at present engaged in commercial geology with offices at Buenos Aires, Argentina, recently visited Washington on his way to Europe.

W. P. Woodring, of the U. S. Geological Survey, has accepted an appointment as Professor of Invertebrate Paleontology at the California Institute of Technology at Pasadena, to take effect in September.

Frank Reeves has been granted leave from the U. S. Geological Survey for four months to do commercial work in petroleum geology in Canada.

F. L. Ransome, formerly geologist of the U. S. Geological Survey, has resigned from the faculty of the University of Arizona and has accepted the Professorship of Economic Geology at the California Institute of Technology, Pasadena.

M. N. Short, of the U. S Geological Survey, has been appointed Lecturer in Mining Geology at Harvard University during the absence of Professor Graton on his sabbatical year.

Obituary

Doctor **Erwin F. Smith**, a member of the Academy, a distinguished scientist of the Department of Agriculture and internationally known plant pathologist, died at his home in Washington, D C., April 6, 1927. Dr Smith was born at Gilbert Mills, N. Y., Jan 21, 1854, but early removed to Michigan, where he obtained his university training and lived until he came to the Department of Agriculture in 1886. At that time but little attention was given to plant diseases and few believed that bacteria were the cause of them. Long before the end of Dr. Smith's 40 years of diligent service, he was recognized as one of the foremost plant pathologists in the world and leader in a branch of science which now exceeds in number of workers any other branch of botanical endeavor in this country. Dr. Smith was the author of a three-volume monograph on Bacteria in Relation to Plant Diseases and An Introduction to Bacterial Diseases of Plants, besides a vast number of contributions in scientific journals. One of his most important contributions to science and one which attracted world-wide attention was his work on certain plant cancers. He proved that these were caused by bacteria, and suggested the probability that animal cancers were also of bacterial origin, pointing out the striking analogies between the tumors of plants and animals. Besides his direct contributions Dr. Smith forwarded science by the help and encouragement he gave to a generation of younger workers. He was president of the Society of American Bacteriologists in 1906, of the Botanical Society of America in 1910, of the American Phytopathological Society in 1916, and of the American Society for Cancer Research in 1924. At the time of his death he was in charge of the Laboratory of Plant Pathology in the Bureau of Plant Industry.

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CHEMISTRY.—*The element "mosandrum" of J. Lawrence Smith.*[1] Roger C. Wells, U. S. Geological Survey.

Before the discovery of the rare earth element illinium by Hopkins[2] American chemists sometimes lamented the fact that no elements had been discovered in this country. It is true that Hillebrand had collected helium from uraninite but he did not recognize it as a new element. A few claims had been made but not substantiated. On the other hand, it is well known that J. Lawrence Smith definitely claimed the discovery of a new element in samarskite, which he called "mosandrum," but the fact that this name is not in the present list of elements tacitly suggests to most people that Smith did not find a new element. As a matter of fact he undoubtedly had at least one new element, perhaps three, in a certain fraction of "cerium earths," but his name "mosandrum" failed to hold for any of these elements on account of a peculiar combination of circumstances. Too many chemists were claiming new elements at that particular period and in the mix-up of conflicting claims Smith, Delafontaine and Soret "lost out," though each was dealing with material containing new elements, as shown by subsequent developments.

Smith's well known method for determining the alkalies is a good one but the method he used for analyzing samarskite, a mineral containing a great variety of elements, has since been found to be incomplete and to yield imperfect separations of some of the constituents. For example, calcium and lead were apparently not found by him. As he was one of the first to study the rare earths of samarskite his preparations containing a supposed new earth were naturally less pure than those made by later investigators.

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[1] Published by permission of the Director, U. S Geological Survey. Received July 2, 1927.

[2] Ind. Eng. Chem , News edition, Mar 20, 1926; Jour Franklin Inst **204**: 1. 1927.

In spite of the shortcomings just mentioned reasons can be advanced for giving Smith credit for the discovery of samarium, and probably also of gadolinium and possibly europium. Working on earths obtained from samarskite in 1877 he modestly claimed the discovery of only one new element, which he shortly afterwards named mosandrum. It should be recalled that the only elements of the rare earth group recognized in 1877 were yttrium, cerium, lanthanum, didymium, erbium and terbium. But about the same time Delafontaine thought that he had found a new earth in "yttria," the element of which he named philippium, and another in "didymia," whose element he named decipium, so that when he and Marignac hesitated to recognize "mosandrum," the weight of their authority and the uncertainties of the questions involved left the identity of "mosandrum" in doubt.

Smith sent a communication to the French Academy[3] in September, 1877, (which was, however, not read until the next July) in which he stated that the "cerium earths" extracted from samarskite contained an earth (about 3 per cent of the mineral) which he regarded as new, if it was not terbium, which Delafontaine thought it might be. Its molecular weight was 327. It was more soluble in dilute nitric acid than ceria, also in an alkaline solution through which chlorine is passed. It differed from didymia in color and in the fact that its solutions showed no absorption spectrum, and from lanthana in color and in the great ease with which its salts are decomposed by heat.

Shortly afterwards he proposed the name mosandrum for the new element.

In the light of present knowledge the element thus claimed by Smith could only be samarium, europium or gadolinium, as Smith was not considering the yttrium group. Let us see what happened in the next few years. Smith generously distributed samples of the earths extracted from samarskite to several American and French chemists for any further studies they might wish to make.

Delafontaine and Marignac criticised Smith's announcement of a new element adversely,[4] but it must be remembered that they were at that time strenuously engaged in establishing their own claims to the discovery of new elements.[5]

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[3] Acad. sci. C. R. 87: 146. 1878.

[4] Delafontaine, Acad. sci. C. R. 87: 600 1878; Marignac, *idem*. 87: 281. 1878.

[5] Delafontaine, Arch. sci. phys. nat. 61: 273 1878; Acad. sci. C. R 87: 559. 1878; Marignac, Arch. sci. phys. nat. 64: 97. 1878; Acad. sci. C. R. 87: 578. 1878.

In the years intervening between 1878 and 1886 Lecoq de Boisbaudran, through fractionations, accompanied by spectroscopic study, of earths associated with "didymia," found, characterized and named samarium[6] (from the mineral samarskite). He said, "I think I should state here that the recognition of the new metal is the fruit of the independent researches of several persons. To each should eventually be attributed his just share in the discovery." These "unnamed persons" were J. Lawrence Smith, Delafontaine, Soret, and Marignac. The name mosandrum might have been applied to the element that was designated samarium, although Lecoq de Boisbaudran made no mention of Smith's element at the time he proposed the name samarium.

In the same period Marignac isolated the oxide of a metal, Y_α, that he supposed might be the element claimed by Smith.[7] His methods included fractional decomposition of the nitrates by heat and fractional precipitation of the sulphates by potassium sulphate. Smith had also used these methods but Marignac repeated the operations many times and, as Crookes showed by means of a characteristic phosphorescent spectrum, his product, Y_α, was pure, whereas that of Smith was impure. The same fraction containing Y_α was also prepared by Crookes. The element Y_α was later named gadolinium.[8] It might possibly also have been considered to be mosandrum.

Finally, in 1886, some material that had been prepared by Smith in Louisville several years before was examined by Lecoq de Boisbaudran,[9] who actually found in it, after removing didymium, both samarium and gadolinium, with some terbium, thus substantiating in a remarkable way Smith's original claim of a new element in samarskite.

Europium was not characterized until afterwards but may have been present as part of the "samarium." It is not easy to say who really discovered europium.

It must be admitted that Smith recognized a new earth in samarskite, but he did not obtain it in a pure state. For that matter, however, the first preparations of yttria, ceria, didymia, terbia, erbia, ytterbia, samaria, and holmia were all later shown to be impure, although they were credited to their discoverers as new.

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[6] LECOQ DE BOISBAUDRAN, Acad. sci C. R. 88: 322; 89: 212. 1879.

[7] MARIGNAC, Acad. sci. C. R. 90: 899. 1880; *idem*, 102: 646. 1886; CROOKES, *idem.*, 102: 646. 1886.

[8] LECOQ DE BOISBAUDRAN, Acad. sci. C. R. 102: 902. 1886.

[9] LECOQ DE BOISBAUDRAN, Acad. sci. C. R. 102: 647. 1886.

It required the spectroscopic work of Lecoq de Boisbaudran to isolate samarium, and he is generally recognized as its discoverer in spite of his credit to several other unnamed persons. On the other hand, the spectroscopic work of Crookes established the identity of gadolinium but its discovery is generally credited to Marignac. Smith and Crookes should share to some extent in that honor.

Marignac on several occasions insisted that Smith's element could not be either of those claimed as new by himself or Delafontaine (philippium, decipium, and Y_α), because its oxide was supposed to be yellow. But Smith did not say that his new earth was yellow; moreover, he says that its salts show no absorption spectrum. One cannot help feeling that Marignac's insistence that Smith's earth was yellow had more weight than it should have had in discrediting Smith's real discovery. Smith may have realized that color is a deceptive guide, as small quantities of foreign oxides show strongly in the colorless earths. On the other hand, it was only after Soret's spectroscopic study that Smith had sufficient confidence to advance the definite name mosandrum for the element he claimed as new.

When all the facts are considered, it appears that J. Lawrence Smith should be given credit for recognizing the existence of a new element in samarskite, although his own preparations were impure and his characterization of the element was indefinite. The element he named "mosandrum" was in fact not one but at least two elements later given the new names samarium and gadolinium.

MINERALOGY—*Sericite-lazulite pseudomorphs after orthoclase from Bolivia.*[1] EARL V. SHANNON, U. S. National Museum.

The following description pertains to some very interesting specimens in the collection of the late Frederick A. Canfield of Dover, N. J., which is now in the National Museum. The specimens were collected personally by Mr. Canfield in 1886 while he was in charge of the mines of the Royal Silver Mines of Bolivia, Limited. There are several examples of the material in the collection (Original Numbers 1650, 5138, 5140) and others were contained in the duplicate material from the Canfield collection purchased from the estate by the Mineralogical Museum of Harvard University.

The specimens bear the label "Turquois? ps. after orthoclase in porphyry, Real Socavon, Potosi, Bolivia," and an additional memorandum on one of the labels states that "these crystals have never had a complete analysis. The late L. C. Bierwirth found that they were a phosphate of alumina." The crystals in question consist of pale to deep turquoise-blue pseudomorphs after orthoclase phenocrysts sparsely scattered through a highly altered quartz porphyry. The groundmass is a pale buff mass of sericitic material containing scattered minute crystals of pyrite. The original embayed crystals of quartz are unchanged and the porphyritic structure of the rock is perfectly retained. The larger orthoclase phenocrysts are now entirely composed of the turquoise-blue material. These are either simple crystals or Carlsbad penetration twins. They are thick tabular parallel to the (010) pinacoid and are somewhat longer than broad reaching extreme dimensions of 33 × 22 × 7 mm. The crystal habit is usual, the only forms represented being the pinacoid *b*(010), the prism *m*(110), the base *c*(001), and the back dome *y*($\bar{2}$01). Coming, as they do, from the walls of a tin vein, these are strongly reminiscent of the perfect Carlsbad twin pseudomorphs of cassiterite after orthoclase, from the walls of tin veins in Cornwall, which are to be found in old collections.

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[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received August 2, 1927

The feldspar phenocrysts of intermediate size are not twinned and range in constitution from those consisting of an outer crust of blue material surrounding a core of sericite, often stained brown by iron, to masses of soft white sericite including only a grain or two of blue substance. The smaller phenocrysts, probably originally plagioclase, are now silky white sericite without any of the blue material.

Several of the broken or imperfect pseudomorphs were detached from the matrix for study. When these were crushed they were found to contain small perfect euhedral crystals of arsenopyrite, pyrite and quartz in a soft and lustreless blue groundmass. The whole mass was ground and screened and the quartz and sulphides separated with methylene iodide-bromoform heavy solutions. The blue material was further separated into heavier and lighter fractions. It was hoped that the blue mineral could be isolated for analysis by this method, but microscopic examination of the best concentrates which could be prepared indicated this to be impracticable. The purified material consisted of scattered blue grains in an abundant matrix of aggregated grains of sericite. Mechanical separation proved impossible and neither blue mineral nor matrix were attacked by boiling 1:1 hydrochloric acid. When the material was fused with sodium carbonate and dissolved in nitric acid, the solution reacted strongly for phosphoric acid with ammonium molybdate reagent. When ignited it turned brown, and when the brown material was digested in acid the solution contained aluminum but gave no reaction for copper.

Under the microscope the determination of the optical properties is difficult owing to the small size of the grains of the blue material, their aggregate character, and the confusion with the intergrown sericite. Determination of the refractive indices is especially difficult but the mean index, β, is about 1.654. The birefringence is moderately low and the grains perpendicular to an optic axis do not extinguish in white light but owing to the high dispersion give abnormal blue and liver-brown colors. The mineral is biaxial and negative, with 2V very small. The dispersion, $r<v$, is very strong. There is a suggestion of imperfect cleavage in one direction and the grains are distinctly pleochroic with X colorless, Y and Z blue. These optical properties differ from those given by Larsen for lazulite in that the indices are higher and the axial angle is smaller. The mineral agrees with lazulite in dispersion, optical sign, and pleochroism. The optical properties other than sign agree more nearly with turquoise but that mineral is optically positive. This difference and the fact that no copper could be detected support the identification of the blue phosphate as lazulite. The higher indices and smaller axial angle are doubtless traceable to difference in composition between this Bolivian material and the ordinary Georgia lazulite upon which the data in Larsen's tables are based.

The possibility that the mineral is an abnormally biaxial manganapatite was considered but rejected. After long boiling with 1:1 nitric acid the blue material was not dissolved, and the extract gave a barely perceptible manganese color with ammonium persulphate. The extract reacted for phosphoric acid but this is doubtless due to a small amount of apatite of ordinary character which occurs as minute grains and prisms scattered through the sericitic material.

PALEONTOLOGY.—*A new early Ordovician sponge fauna.*[1] R. S. BASSLER, U. S. National Museum.

Although a few individual species are found sometimes in great numbers, Paleozoic sponges are comparatively rare. The discovery of an entirely new fauna comprising two families, one of them represented by five new genera, is therefore of unusual interest. This exceptional

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[1] Received July 25, 1927.

assemblage of new sponges was discovered in early Ordovician rocks of Chazyan age by Messrs. H. G. Clinton and Percy Train of Manhattan, Nevada, two enthusiastic students of the geology of this state, who transmitted the specimens to me for determination and presented a generous set to the U. S. National Museum upon condition that they be described. The exact locality of these new sponges is in McMonnigal Canyon, about 10 miles west of the Devil's Punch Bowl in Monitor Valley and about 60 miles north of Manhattan, Nevada. According to Mr. Train, the limestones outcropping here are several thousand feet thick and form the main backbone of the Monitor Range on the west side of the valley. All the new sponges occur near the valley floor in the lower few hundred feet of the series.

The specimens are found in somewhat shaly limestone, often attached to thin fossiliferous layers containing brachiopods, trilobites, and other invertebrates of decided Chazyan aspect. Among the various forms of trilobites noted, several are new species of exceptional interest, and one occurs abundantly which upon close study cannot be distinguished from *Pliomerops barrandei* Billings, originally described from the Chazyan of Newfoundland. Curiously enough, most of the sponges belong to the family Archaeoscyphidae, hitherto represented only in strata in the easternmost portion of North America.

As Messrs. Clinton and Train have a considerable number of these new sponges which they wish to send out to students, they have asked me to issue this preliminary note in advance of a more detailed, illustrated article so that they may have names for their specimens. All of their specimens can be classified under two Early Paleozoic families: first, the Anthaspidellidae Ulrich and Everett, represented by *Anthaspidella* and *Streptosolen;* and second, the Archaeoscyphidae Rauff, hitherto known from a single genus and species but now augmented by five new genera. The following brief descriptions give the general features of these new forms.

SILICISPONGIAE

Order TETRACTINELLIDA

Family ARCHAEOSCYPHIDAE Rauff

Sponge attached, simple or branching, ranging from saucer and funnel shapes to turbinate and frondescent; simple or branched cloaca usually of considerable diameter; oscula represented by numerous, closely spaced, small pores penetrating the spicular tissue of the wall and opening on the outer surface at regular intervals. Spicular structure much as in the Anthaspidellidae.

Genus **Nevadocoelia**, n. gen.

Simple, erect, obconical, pedunculate sponges pierced throughout their length by a wide cloaca and marked on their outer surface by transverse ridges or rows of nodes.

Genotype.—Nevadocoelia wistae, n. sp.

Nevadocoelia wistae, n. sp.

Sponge elongate, as much as 12 centimeters in length and 4 centimeters in greatest width, tapering gradually towards the base, with the surface marked by undulating, more or less parallel transverse ridges, of which 7 occur in 3 centimeters.

The specific name is in honor of Miss Meta Wist of Manhattan, Nevada, in appreciation of her interest in the natural history of that state.

Nevadocoelia traini, n. sp.

Similar in growth to the preceding but with the surface marked by sharp nodes instead of transverse ridges. These nodes are arranged in somewhat irregular transverse rows and six of them occur on an average in 2 centimeters, measuring transversely.

Nevadocoelia grandis, n. sp.

Sponge not unlike *N. wistae* in structure but much larger. The diameter is 7.5 centimeters and the ridges stronger, with only 3.5 in 3 centimeters.

Nevadocoelia pulchra, n. sp.

Sponge 7 centimeters in diameter and more than 11 centimeters high with the cloaca 2 or more centimeters wide; marked by unusually large surface ridges which form wide, ascending, flange-like expansions and measure at least 1.5 centimeters distant from each other.

Genus **Lissocoelia**, n. gen.

Sponge consisting of smooth, cylindrical, hollow stems, branching at irregular intervals. Surface minutely porous and with the general structure of the family. Cloaca narrow but extending the full length of the sponge.

Genotype and only species.—Lissocoelia ramosa, n. sp.

Lissocoelia ramosa, n. sp.

Sponge smooth, branching, usually about 1.5 centimeters in diameter but increasing to 2 centimeters at a division point; the cloaca 0.5 centimeters wide. Surface smooth, marked by small rounded pores distributed equally throughout the spicular tissue.

Genus **Calycocoelia**, n. gen.

Sponge cup-shaped with the cloaca increasing in width from below upward and opening at the upper outer surface as a deep excavation. Surface smooth and exhibiting the general microscopic structure of the family.

Genotype and only species.—Calycocoelia typicalis n. sp.

Calycocoelia typicalis, n. sp.

The cup-shaped form, smooth surface, and wide cloaca of this species, 7 centimeters in diameter at the top and less than 4 near the base, characterize this interesting species.

Genus **Patellispongia**, n. gen.

Sponge as found in the rocks consisting of lamellar fragments, sometimes of considerable dimensions, but originally probably broad saucer-shaped expansions attached by a short stem. Under surface comparatively smooth, covered by a thick dermal tissue which when weathered shows regular canals or channels. Upper surface with numerous evenly spaced rounded pores surrounded by the usual spicular tissue.

Genotype.—Patellispongia oculata, n. sp.

Patellispongia oculata, n. sp.

This species forms broad lamellar expansions with the upper surface exhibiting numerous rather regularly spaced pores 1 millimeter in diameter with 6 to 7 in 10 millimeters.

Patellispongia clintoni, n. sp.

Sponge similar to the preceding in growth but the pores slightly larger and, more important from a specific standpoint, almost 5 millimeters apart.

Patellispongia minutipora, n sp.

Sponge consisting of thin lamellae and differing particularly from other members of the genus in the minuteness of the pores, since at least 15 can be counted in 10 millimeters.

Genus **Hesperocoelia**, n. gen.

General structure similar to that of *Patellispongia* save that the broad saucer-shaped lamella of that genus is here represented by a flat, undulated, two-leaved frond pierced along the upper edge by a row of rounded or oval openings which constitute the cloaca.

Genotype —Hesperocoelia typicalis n. sp.

Hesperocoelia typicalis, n. sp.

Sponge a flattened, flabellate frond more than 5 centimeters high and about 6 millimeters in thickness, traversed by longitudinal canals of varying diameter which emerge at the surface along the upper thin edge in a row of narrow openings, each about 3 millimeters long, spaced so that 5 occur in 20 millimeters The usual pores in the spicular tissue show on both sides of the sponge with an average of 4 pores in 3 millimeters, measuring longitudinally.

Hesperocoelia undulata, n. sp.

This species differs decidedly from the preceding in that the openings along the upper edge of the sponge are round, 4 millimeters in diameter with about 3 5 in 20 millimeters. Moreover, the small pores penetrating the spicular tissue are more delicate and closely spaced

Family ANTHASPIDELLIDAE Ulrich and Everett.

Genus ANTHASPIDELLA Ulrich and Everett.

This fine genus is represented by two very distinct new species which I have the pleasure of naming in honor of the discoverers of this new fauna.

Anthaspidella clintoni, n. sp.

Although related to *Anthaspidella scutula* Ulrich and Everett from the Black River (Platteville) limestone at Dixon, Illinois, in that it has the clusters consisting of the oscula and radiating canals comparatively small and close together, the present species differs in that the clusters measure 15 millimeters, on an average, from center to center.

Anthaspidella traini, n. sp.

Sponge suggesting *Anthaspidella florifera* Ulrich and Everett, from the Black River limestone at Dixon, Illinois, but differing in that the clusters are farther apart, averaging 25 millimeters from center to center.

Genus STREPTOSOLEN Ulrich and Everett.

Streptosolen occidentalis, n. sp.

Sponge with the form and general structure of *Streptosolen obconicus* Ulrich and Everett, the genotype, from the Black River (Platteville) limestone at Dixon, Illinois, but differing in that the canals do not intertwine so much and the central osculum is much wider and has larger tubes.

BOTANY.—*The genus* Hampea.[1] PAUL C. STANDLEY, U. S. National Museum.

The genus *Hampea* consists of a small group of American trees and shrubs which has been referred by most authors to the family Bombacaceae, although others have believed its more natural position to be in the Malvaceae. The genus was based by Schlechtendal upon a single species, *H. integerrima,* described from Veracruz. In 1862 Triana and Planchon described a second species, *H. thespesioides,* from Colombia, and in 1886 Sereno Watson a third from Guatemala. A variety of *H. integerrima* was described from Costa Rica in 1899 by Capt. John Donnell Smith, and in 1923 I transferred to the genus a Mexican plant described as a *Thespesia* by Presl, and published a new species from the Yucatán Peninsula.

Practically all the scanty herbarium material of the genus has been referred without question to the original *H. integerrima.* Our representation of the genus has increased rapidly in recent years, and when an attempt was made recently to name two Central American specimens, it became evident that the group was badly in need of revision.

In the present treatment nine species are recognized, one indigenous in Colombia, the others ranging from Panama to southern Mexico.

Through the courtesy of Dr. B. L. Robinson the material of this genus in the Gray Herbarium has been lent for study by the writer.

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[1] Published by permission of the Secretary of the Smithsonian Institution. Received July 7, 1927.

HAMPEA Schlecht. Linnaea 11: 371. 1837.

KEY TO THE SPECIES

Leaf blades with small auriculiform appendages at base. Leaves entire; capsule glabrous within except along the sutures; calyx in bud closed, in anthesis irregularly lobed.
Appendages of the leaf blade 5 mm. long; capsule 2–2.3 cm. long; seeds 8 mm. long.............. **1. H. appendiculata.**
Appendages 2 mm. long; capsule 1.5–1.7 cm. long; seeds 5 mm. long. **2. H. panamensis.**
Leaf blades not appendaged at base.
Leaves glabrous beneath or essentially so.
Leaves entire; calyx truncate, not closed except in very young buds, 5–7 mm. long. Capsule densely hispid within. **3. H. integerrima.**
Leaves 3-angulate; calyx closed in bud until shortly before anthesis, irregularly lobate, 10 mm. long....... **4. H. Rovirosae.**
Leaves obviously stellate-tomentose beneath. Capsule glabrous within except along the sutures.
Leaves cordate at base, angulate or lobate.
Pedicels solitary; leaves 5 or 7-nerved at base. . **5. H. thespesioides.**
Pedicels in dense clusters in the leaf axils, leaves 9-nerved. **6. H. platanifolia.**
Leaves truncate or rounded at base or merely concave, not cordate.
Capsules 2.5–3 cm. long. Leaves entire. **7. H. tomentosa.**
Capsules 1–1.8 cm. long.
Leaves entire, usually abruptly acuminate, sparsely and minutely stellate-pubescent beneath; pedicels in anthesis 1.4 cm long or shorter.................. **8. H. stipitata.**
Leaves mostly angulate or shallowly lobate, rounded to acute at base, densely and coarsely stellate-tomentose beneath (in age sometimes glabrate); pedicels in anthesis mostly 2–3.8 cm. long .... . **9. H. trilobata.**

1. **Hampea appendiculata** (Donn. Smith) Standl.

Hampea integerrima var. *appendiculata* Donn. Smith, Bot. Gaz **27**: 331. 1899.

Although described originally as a variety, it is evident that this Costa Rican plant is worthy of specific rank. It differs from *H. integerrima* in its appendaged leaves; lobed, not truncate calyx; and in the glabrous rather than hispid inner surface of the capsule. The following specimens are at hand: COSTA RICA: La Palma, alt. 1,550 m, *Tonduz* 12462 (*J. D. Smith* 7379; type). La Hondura, Prov. San José, alt. 1,300 m, *Standley* 37627, 36141. Tilarán, Guanacaste, alt. 600 m., *Standley & Valerio* 44401. Platanares (Moravia), *Rowlee & Jiménes* 208. El Muñeco, Prov. Cartago, alt. 1,400 m., *Standley & Torres* 50941. Los Ayotes, Guanacaste, alt 600 m., *Standley & Valerio* 45458. Naranjos Agrios, Guanacaste, alt. 600 m., *Standley & Valerio* 46427. La Tejona, Guanacaste, alt. 600 m, *Standley & Valerio* 45922.

This species is usually a small tree, 5 to 25 meters in height. It is common in the wet forests of central Costa Rica and of the Province of Guanacaste. The local name is "buriogre."

2. **Hampea panamensis** Standl., sp. nov.

Medium-sized tree, the trunk sometimes 60 cm. in diameter; young branches densely stellate-tomentose, the tomentum minute, ferruginous or ochraceous; petioles slender, 3.5–6.5 cm. long, stellate-tomentose; leaf blades ovate or broadly ovate, 9–22 cm. long, 5–12 cm. wide, entire or slightly undulate, abruptly acuminate or merely acute, at base truncate or rounded and often asymmetric, auriculate-appendaged at the insertion of the petiole, the appendages rounded, 2 mm. long; blades membranaceous, deep green on the upper surface, when young sparsely and very minutely stellate-puberulent but in age glabrous or nearly so, beneath paler, covered with a minute, appressed, rather dense stellate tomentum of fulvous hairs, 5-nerved at base; flowers numerous, fasciculate in the leaf axils, the pedicels 5.9 mm. long, stellate-tomentose; bractlets 3, narrowly triangular or subulate, 2–2.5 mm. long, appressed to the calyx, caducous; calyx in bud closed, globose, in anthesis campanulate, 6 mm. long, minutely tomentose, shallowly and irregularly 3-lobate, the lobes rounded; petals spreading or reflexed, 1 cm. long, densely and very minutely tomentose outside, glabrous within, gland-dotted; capsule obovoid-globose, short-stipitate, 1.5–1.7 cm. long, rounded at apex, verruculose and brown-tomentose, 3-valvate, within hispid along the sutures but elsewhere glabrous; seeds 2 in each cell, oval, 5 mm. long, blackish brown, lustrous, the aril caplike, covering less than half of the seed; pedicels in fruit slender, about 2 cm. long, the calyx persistent.

Type in the U. S. National Herbarium, no. 1,269,804, collected in the Almirante region, Province of Bocas del Toro, Panama, in 1927, by G. P. Cooper and G. M. Slater (no. 15). The following collections also belong here:

PANAMA: Almirante region, *Cooper & Slater* 8. Changuinola Valley, *V. C. Dunlap* 227.

The vernacular names are given as "burío" and "azote." The wood is described as creamy gray and of medium coarse texture.

Hampea panamensis is closely related only to *H. appendiculata*, which has rather narrower leaves with much larger appendages, and with a denser tomentum on the lower surface, and larger capsules and seeds.

3. **Hampea integerrima** Schlecht. Linnaea **11**: 372. 1837.

This is the type of the genus. The original material was collected near Josocola and Hacienda de la Laguna, Veracruz, by Schiede. The plant is very uniform in foliage, flower, and fruit characters. The following specimens have been examined:

VERACRUZ: Zacuapan, *Purpus* 4453, 4453a, 8030 (Gray Hb.), 10748. Orizaba, *Botteri* in 1856; *Bourgeau* 3116 (Gray Hb.). Mirador, *Liebmann* 393. Misantla, *Purpus* 5925. Jalapa, *C. L. Smith* 1536 (Gray Hb.).

OAXACA: Colonia Melchor Ocampo, *Conzatti* 173 (Gray Hb.).

Known in Veracruz as "jonote blanco."

4. **Hampea Rovirosae** Standl., sp. nov.

Young branchlets very sparsely and minutely stellate-puberulent, soon glabrous or nearly so, petioles slender, 3.5–16 cm. long, glabrate, leaf blades rounded-ovate to suborbicular, 8–17 cm. long, 7–16 cm. wide, abruptly short-acuminate to obtuse, at base truncate or subcordate, the smaller leaves entire, the larger angulately 3-lobate, membranaceous, deep green above, glabrous or nearly so, beneath slightly paler, with a few minute stellate hairs scattered along the nerves, elsewhere glabrous, 7-nerved at base; flowers fasciculate in the leaf axils, the pedicels stout, 5–15 mm. long, minutely and sparsely stellate-puberulent; bractlets filiform, 3 mm. long; calyx ovoid in bud, in anthesis irregularly and shallowly cleft, campanulate, 1 cm. long, minutely stellate-tomentose or glabrate, petals reflexed, nearly 2 cm. in total length, broadly rounded at apex, minutely stellate-tomentose on the outer surface, glabrous or nearly so on the inner surface.

Type in the U. S. National Herbarium, no. 943,425, collected on moist banks of the Río Grijalva, Tabasco, Mexico, August 19, 1889, by J. N. Rovirosa (no. 586). Vernacular name, "majagua blanca."

Hampea Rovirosae is closely related to *H. integerrima* and may be only a form of that species. It differs from the latter in the broader, sometimes angulate leaves, and in the larger, irregularly lobed calyx.

5. **Hampea thespesioides** Triana & Planch. Ann. Sci. Nat. Bot. IV. **17**: 188. 1862.

No material has been seen of this species, the only one occurring outside Central America and Mexico. It is reported, in the original publication, from the following localities:

COLOMBIA: Forests of the Province of Antioquía, alt 700 m, *Triana.* Between Las Ceibas and Honda, and between El Peñón and Quebrada Grande, *Goudot.* Near Muzo, *Purdie.*

The vernacular names are "zapotillo" and "achote cimarrón."

Judging from the description, *H. thespesioides* is related to the following Costa Rican species. The authors give no dimensions of the parts of the plant, and detailed comparison is therefore difficult.

6. **Hampea platanifolia** Standl., sp nov.

Large shrub or small tree, with few branches, the young branchlets densely and coarsely stellate-tomentose with brownish pubescence; petioles stout, 16–27 cm. long, stellate-tomentose; leaf blades rounded-cordate in outline, 18–30 cm. long and usually of equal or greater breadth, rounded to cuspidate-acuminate at apex, at base shallowly or usually deeply cordate, the sinus narrow or broad, 3–7 cm. deep, the blades angulately 3 or 5-lobed, the lobes broadly rounded or obtuse, often cuspidate, membranaceous, deep green on the upper surface, when young densely stellate-tomentose, the tomentum persistent along the nerves, rough to the touch, beneath paler, at first densely and rather coarsely stellate-tomentose with fulvous hairs, the tomentum in age sparser but copious, the blades 9-nerved at base, flowers numerous, densely clustered in the leaf axils, the pedicels stout, 8 mm long or shorter, coarsely stellate-tomentose, bractlets linear or filiform, 4–6 mm long, deciduous; fully developed flowers not seen; calyx at first closed, but expanding before anthesis, broadly campanulate, 5 mm long and 7 mm broad, densely and minutely tomentose, subtruncate and remotely repand-dentate, the 5 teeth short, narrowly triangular; corolla in bud densely and minutely stellate-tomentose outside; pedicels in fruit stout, 2–3 cm. long; capsule densely and coarsely stellate-tomentose with yellowish tomentum, short-stipitate, 3-valvate, the valves 3.5–4.5 cm. long, 13–15 mm. wide, glabrous within except along the sutures, there hispid, the cells apparently about 5-seeded.

Type in the U. S. National Herbarium, no. 938,656, collected in forest near El Copey, Province of San José, Costa Rica, altitude 1,800 meters, February, 1898, by A. Tonduz (no. 11667). Three other sheets of the same collection are in the National Herbarium.

Collected also at Capulín, on the Río Grande de Tárcoles, Province of Alajuela, Costa Rica, altitude 80 meters, April 2, 1924, *Standley* 40177.

It is unusual in Costa Rica to find a species which grows at so great an elevation as 1,800 meters occurring at sea level, but it is probable that seeds have been transported downstream from the mountains to Capulín, where I found the plant growing.

Hampea platanifolia is very unlike the other Central American species in its large, broad, long-petiolate leaves. It appears to be related to *H. thespesioides*, although the description of the latter species is deficient in some important details. Only open capsules of the Costa Rican plant are available. Their long narrow valves indicate that the fruit must be very narrow in outline, and decidedly different from the globose capsule found in other species.

7. **Hampea tomentosa** (Presl) Standl. Contr. U. S. Nat. Herb. **23**: 787. 1923

Thespesia tomentosa Presl, Rel. Haenk. **2**: 136. 1836.

The type was collected by Haenke in western Mexico. The following collections are in the National Herbarium:

OAXACA: Cafetal San Rafael, Distrito de Pochutla, alt. 800 m., *Conzatti, Reko & Makrinius* 3292. Cafetal Montecristo, alt. 800 m., *Reko* 3428.

SALVADOR: Ahuachapán, alt. 800 m., *Standley* 19811.

8. **Hampea stipitata** S. Wats. Proc. Amer. Acad. **21**: 460. 1886.

The following specimens have been examined:

GUATEMALA: Chocón Plantation, a large tree, March 20, 1885, *Watson* 31 (type; Gray Hb.). Quiriguá, *Standley* 24600. Finca Sepacuité, Alta Verapaz, *Cook & Griggs* 576, in part.

HONDURAS: Near Puerto Sierra, *Wilson* 62. Near Cuyamel, *Record & Kuylen* 17. San Pedro Sula, *Thieme* 5603.

Known in Honduras as "majao colorado."

9. **Hampea trilobata** Standl. Contr. U. S. Nat. Herb. **23**: 787. 1923.

Specimens have been examined, as follows:

CAMPECHE: Apazote, Dec. 27, 1900, *Goldman* 488 (type).

YUCATAN: Izamal, *Gaumer* 845. Cotilcim, *Gaumer* 23386. Without locality, *Gaumer* 24260.

BRITISH HONDURAS: Without locality, *Record* in 1926; *Winzerling* V.18.

Known in British Honduras as "moho." The Maya name used in Yucatán is given as "toobhoob."

ZOOLOGY.—*Note on the occurrence of the Six-Lined Race-Runner in the District of Columbia.*[1] C. S. EAST, U. S. National Museum. (Communicated by A. WETMORE.)

A specimen of the Six-Lined Race-Runner, *Cnemidophorus sexlineatus* (Linn.) was collected June 10, 1927, at Terra Cotta, within the District of Columbia, by Mr. August Busck of the Bureau of Entomology. Numerous other individuals of this lizard were observed at this place. So far as is known this is the first specimen of the species taken in the District. The nearest locality hitherto recorded is the junction of the Defence and Crain Highways, Prince George's county, Md., a distance of about 20 miles, where Mr. M. K. Brady recently took three specimens. Previous to this the nearest records were from Chesapeake Beach, Calvert County, Md. Dr. W. P. Hay in *A List of the Batrachians and Reptiles of the District of Columbia and Vicinity* (Proc. Biol. Soc. Washington **15**: 134. 1902) says: "As to the occurrence of this species within our limits there is some doubt, but it has been taken at no great distance both north and south so it will doubtless be found here sooner or later." The specimen collected by Mr. Busck has been placed in the collection of the United States National Museum (U. S. N. M. 72592).

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

954TH MEETING

The 954th meeting was held at the Cosmos Club March 19, 1927. The program of the evening was given in commemoration of the 200th anniversary of the death of Sir Isaac Newton.

Program: FREDERICK E. BRASCH, *Life of Sir Isaac Newton, and his contemporaries.*

EDGAR W. WOOLARD, *The place of Sir Isaac Newton in the history of pure mathematics.* The great reputation of Sir Isaac Newton as a pure mathematician rests chiefly, though not exclusively, on the fact that he was one of the founders of the Infinitestimal Calculus, to the invention of which the greater part of the mathematics and physics of today owes its existence. The development of the concepts which Newton employed in constructing the Calculus may be traced back directly to the ancient Greeks; by the time of Newton a crude process of integration was in common use, and considerable approach had been made to differentiation but all his predecessors missed the *analytical method* which he devised—there was no differential or integral *calculus*, properly so called.

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[1] Received August 1, 1927.

While the practical advantages of Newton's methods far exceeded those of all previous results, nevertheless the methods of the ancient Greeks were considerably superior in respect to soundness of theory. Newton's work is an interesting example of the way in which, even in mathematics, a correct intuition may appear and lead to a great wealth of new knowledge long before a logical proof of its correctness can be supplied, or even before the intuition itself can be correctly formulated Neither Newton nor his contemporaries ever succeeded in placing the calculus on a satisfactory foundation; the rules appeared to give correct results, but it was not known why they did; all of Newton's expositions of his calculus were vague, and encumbered with difficulties, the validity of the calculus was more than once questioned, often with good reason. Newton originally based his calculus on infinitesimals, using these to obtain his so-called fluxions, he later altered the foundations several times; he never used the method of limits to construct the calculus.

During the period immediately following Newton, mathematicians, with great skill, exploited the wonderful powers of the new calculus, and extensively developed the purely *formal* part, but gave little attention to the foundations of the subject The serious difficulties in which they, as a result, became involved led to a period of *critical* work during which modern standards of rigor came into existence. Subsequent work in pure mathematics has consisted of building up the superstructure to greater and greater heights, while tying its parts together more and more firmly by severer standards of rigor, and basing the whole on ever deeper and stronger foundations, until at the present time the great structure of modern pure mathematics, while not perfect, is nevertheless the securest structure known to human thought. (*Author's abstract*)

T. B BROWN, *The contribution of Newton to optics*

PAUL R. HEYL, *The contribution of Newton to mechanics and astronomy.* Newton was a good deal of a general practitioner in science, as were all of the scientific men of his day His work in optics and in mathematics was important but not more so than that of a dozen others. Why, then, is his name preeminently remembered. If we look for the reason in his contributions to mechanics and astronomy as set forth in the Principia, we find that most of the facts therein stated were not original with Newton

His preeminence lay in his breadth of vision He correlated the disjointed facts of his day which had been discovered by others and his bequest to his successors is a permanent economy of thought and a new point of view. (*Author's abstract*)

955TH MEETING

The 955th meeting was held at the Cosmos Club April 2, 1927.

President AULT announced the death of Dr. WILLIAM H. DALL who was the last surviving founder of the Society

The address of the evening was given by Dr. W. H. HOBBS of the University of Michigan on *The first Greenland expedition of the University of Michigan.* The University of Michigan expeditions to Greenland have had as their primary object a study of the air circulation over the vast ice-cap (continental glacier) which covers all but a narrow marginal fringe of the continent. We have chosen to make our base within the Holstenborg district of southwest Greenland, where the land ribbon is widest, and this chiefly for two reasons. It was believed that, first, the margin of the inland-ice though here more distant from the coast would be found to afford a less steep marginal surface and hence give an easier route to the interior, and, second, the crossing of the land area where broadest would afford an opportunity to ascertain whether there had been more than a single advance and retreat of the ice-front.

In both these expectations we have not been disappointed. A feasible route to the interior of the ice-cap has been found, and it has been learned that a second advance and retreat of the ice-front has procured a hinterland characterized by subdued topography lying behind the much higher and more rugged topography of the coastal zone

Pilot balloon ascensions have been regularly carried out under the direction of Mr. S. P. Fergusson, our aerologist, whose services were furnished us by the U. S. Weather Bureau for the season of 1926; and an ice-cap party sent up pilot balloons over the ice-cap itself, the first ascensions of this kind to be made either in the Arctic or Antarctic

The first sounding balloons to be sent up in Greenland reached in one case an altitude of 5500 meters and the meteorograph was recovered with record intact These ascents were made possible by use of the new Rossby deflating device

Studies of the effect of a simple fracture system within the rocks introducing a very striking "checker-board" type of relief are being made by Mr. Ralph L. Belknap, the geodosist and geologist of the expedition who is to return to Greenland the present year A study of the raised beaches has been carried out by Dr. Laurence M Gould, assistant director of the 1926 Expedition

It had been expected to advance in 1926 a considerable distance over the inland-ice toward the interior, but after its margin had been reached by four of the party with four Greenlanders, the failure to find game, which had once been abundant in the region, compelled a return on reduced rations and by forced marches after only four days had been spent at the ice-cap This attack upon the ice-cap is to be carried out during the present season

Professor James E Church, Jr, authority on snow surveys and director of the Mount Rose Observatory, is to occupy a mountain station near the margin of the ice-cap and carry out meteorological observations throughout the year from the summer of 1927 to that of 1928. He will have as his companion Mr. P. C Oscanyan, Jr, wireless expert, both having been members of the 1926 Expedition. In this mountain station they will be exposed to the full force of the blizzard winds which blow outward in strophs from the interior of the ice-cap

In cooperation with the Michigan Greenland expedition of 1927–28, Dr Constantin Dumbrava, Director of the Roumanian Greenland expedition, will establish his base near Angmagssali on the border of the ice-cap in southeast Greenland and in about the same latitude. He will also occupy a mountain station and make observations according to the same plan. Cooperative ascents by pilot balloons will be made at both these stations and also at two stations in Iceland by Drs. Georgi of the Deutsche Seewarte of Hamburg, Germany, and Thorkel Thorkelssen of Iceland.

During the present season also the attempt will be made to take soundings of the ice-cap by the echo methods now in use in connection with petroleum surveys. (*Author's abstract.*)

ENTOMOLOGICAL SOCIETY

388TH MEETING

The 388th regular meeting was held December 2, 1926, in Room 43 of the National Museum, with President J. M. **Aldrich**, in the chair and 26 members and 19 visitors present.

J. A. **Hyslop** read the following notice of the death of Dr. Henry Skinner of Philadelphia: The Entomological Society of Washington receives with sorrow and a feeling of serious loss the notice of the death on May 29, 1926, of Dr. Henry Skinner, at one time a corresponding member of this Society. Dr. Skinner, one of the most widely known North American entomologists, was the Conservator of Insects in the Academy of Natural Sciences, Philadelphia. He was for many years the editor of Entomological News, and a member of the International Commission on Zoological Nomenclature. His special entomological interest was in the Lepidoptera, to the literature of which group he made many valuable contributions. In the later years of his life he devoted himself almost exclusively to the Hesperiidae.

Mr. **Rohwer** presented an invitation from the Carnegie Institution to the members of the Society to attend an exhibition on December 11, 12 and 13, illustrating the advances made in scientific methods, and accomplishments in the line of research by the Carnegie Institution.

Program: Dr. E. A. **Richmond**: *Olfactory response of the Japanese beetle.* The paper was illustrated with lantern slides showing various kinds of traps. The greatest activity of the beetles is between 10 A. M. and 4 P. M. The females numbered about one-third more than males.

Discussion by Messrs **Howard**, **Aldrich**, **Richardson**, **Barber**, **McIndoo**, **Graf** and **White**.

Mr. S. E. **Crumb**: *General observations on chemotropism in insects.*

Discussion by Messrs. **McIndoo**, **Richardson**, **Baker**, **Graf** and **Simmons**.

Election of officers for 1927: President, J. A. **Hyslop**; 1st Vice-president, J. E. **Graf**; 2nd Vice-president, A. C. **Baker**; Editor, W. R. **Walton**; Recording Secretary, **Joe. S. Wade**; Corresponding-Secretary and Treasurer, S. A. **Rohwer**. Executive Committee, A. N. **Caudell**, T. E. **Snyder**, and C. T. **Greene**. Nominee from the Society for Vice-President of the Washington Academy of Sciences, A. G. **Böving**.

Chas. T. Greene, *Recording Secretary.*

389TH MEETING

The 389th regular meeting was held January 6, 1927, in Room 43 of the U. S. National Museum. President J. A. **Hyslop** presided. There were present 28 members and 17 visitors.

H. W. **Allen**, Riverton, N. J.; L. M. **Scott**, Washington, D. C., and A. A. **Granovsky**, Madison, Wisconsin, were elected to membership.

Dr. **Howard** announced that he had attended that afternoon the funeral of Mr. John D. Patten, for a number of years a member of the Society and also for some years its Treasurer. He spoke especially of Mr. Patten's hospitality to the Society and his great interest in its work. Mr. Patten's interest seemed to be more in the members of the Society than in the subject, not being an entomologist himself. A committee composed of Messrs. **Howard**, **Caudell**, and **Rohwer** was appointed to present resolutions on Mr. Patten's death.

Program: Dr. J. M. ALDRICH, retiring address: *Limitations of taxonomy.* The speaker discussed a considerable number of physical and psychological limitations, which led him to believe that the ultimate classification of insects is very much farther in the future than commonly believed, even by the taxonomists. The address will be published in full in Science.

Discussed by Messrs. HOWARD, ROHWER, and MORRISON.

Dr. J. M. SWAINE, Ottawa, Canada, conveyed greetings from the Entomological Society of Ontario to the Entomological Society of Washington, and expressed his pleasure at opportunity for studying in the U. S. National Museum, especially in the Casey and other special collections. He spoke briefly of some of his recent field work from Cape Breton to British Columbia, and of a trip on the Pacific Coast and in the Mohave Desert.

Mr RALPH HOPPING, of Vernon, B. C., outlined briefly some of his recent work in British Columbia in control of fruit insects, discussed some noteworthy insect outbreaks, and recorded the collection by him of 173 cutworms around a marigold bush.

Mr. R. E. CAMPBELL, of Alhambra, California, reported on a field trip through parts of Southern California, on which trip he collected a number of rare Bostrichids, *Dinapate wrighti* Horn, from palm trees, on which he later caused the market price to drop from $20 to $5 and less per pair.

Discussed by Messrs. HYSLOP, CURRIE, and SIMMONS.

Prof. W. P. FLINT, of Urbana, Illinois, conveyed greetings from the Illinois entomologists to our Society and expressed his pleasure at being with us.

Prof J. S HOUSER, of Wooster, Ohio, discussed the address of the President and added another chapter to his famous so-called "fishworm story," in which angleworms had been reported by him as attacking onions. He narrated another instance of injury by them, this time to pansies.

Prof. JOHN J. DAVIS, of Lafayette, Indiana, gave some reminiscences of meetings of the Society years ago at Sängerbund Hall. He discussed some of the Indiana work by himself and Mr. Cleveland on the effects of flies on dairy cattle in relation to milk production. They found that spraying the animals notably increased milk flow.

Mr. L. M. PEAIRS, Morgantown, West Virginia, discussed insect conditions in his State and gave reminiscences of attendance at former meetings of the Society.

Mr. A. A. GRANOVSKY, Madison, Wisconsin, referred briefly to recent work by that State in airplane dusting of hemlock forests and to researches conducted by the Experiment Station on the relation of certain leaf-hoppers to alfalfa yellows.

Mr. PEREZ SIMMONS presented a brief paper on the ability of the larva of the cheese skipper, *Piophila casei* Linn., to endure unfavorable conditions. The unusual hardihood of the maggots of the cheese skipper is shown by their ability to withstand starvation, low temperatures, high temperatures, and immersion in many liquids which would be promptly fatal to most insects. The usual duration of larval life in hot weather is five or six days, but when proper food is lacking the larval stage may last for as many months Maggots were found to live in a temperature of 45° to 50°F. for a maximum of seven months. They withstood 32°F. for three months. Half-grown larvae lived for 64½ hours at 5°F. A Russian writer reports that larvae lived two weeks in a temperature of −7°F. Some larvae recovered after exposure to 122° to 124°F. for four hours. They survived about two minutes when immersed in water at a temperature of 129°F. Several European workers have conducted experiments with liquids, such as 95 per cent alcohol, ether, formaldehyde, turpentine, petroleum, carbon disulphide, and xylol, and maggots proved to be surprisingly resistant to immersion in these reagents. Maggots buried by the speaker in Pyrethrum powder pupated in it, and others pupated after immersion for 3½ hours in gasoline. Although other insects are reported to be more resistant to starvation and to high and low temperatures, the all-round hardihood of the cheese skipper larvae appears to be without parallel. (*Author's abstract*)

Discussed by Dr ALDRICH, and by Dr. HOWARD, who narrated a story from Reade's "Cloister and the Hearth."

390TH MEETING

The 390th regular meeting was held February 8, 1927, in Room 43 of the U. S. National Museum. President J A HYSLOP presided. There were present 30 members and 16 visitors

The Secretary-Treasurer reported briefly on a meeting on January 17 of the Executive Committee and read a letter recently received from Dr. Geza Horwath thanking the Society for the friendly greetings sent him in celebration of his 80th birthday He also read a letter from the Honorary President, Dr. E. A SCHWARZ, in which Dr SCHWARZ formally presented to S A. ROHWER as Corresponding Secretary of our Society his library of books and pamphlets. After remarks by Dr HOWARD it was ordered by the Society that suitable resolutions of thanks be transmitted to Dr. SCHWARZ. Not only the gift but the thoughtfulness and affection which prompted it are deeply appreciated by the Society.

The principal feature of the program was a symposium on arsenical spray residue, conducted under the direction of Dr. A. L. QUAINTANCE, who gave a brief historical résumé of the progress of work with arsenicals since about 1860. He called special attention to arsenate of lead, which was developed in 1892 by Prof. Moulton as a treatment for shade and other trees in connection with the control of the gipsy moth in Massachusetts This arsenical was much the best of any available for use on such deciduous fruits as apples and pears by reason of its quality of sticking to fruit and foliage and its harmlessness to the plants In consequence arsenate of lead has become the main dependence of orchardists for the control of such serious pests as the codling moth and plum curculio. In some regions the codling moth especially is excessively destructive and growers have been given to excessive spraying with arsenate of lead, sometimes so late in the season that a considerable amount of arsenate of lead spray residue might be present on the marketed fruit. This condition gradually grew worse and necessitated a decided change in spray practice and the development of methods to remove spray residues on fruit before marketing Not only is arsenic in excessive quantities objectionable, but lead also, an accumulative poison, is considered by pharmacologists and others to be equally or more dangerous. The speaker therefore felt that considerable experimental work should at once be undertaken to determine other arsenicals than arsenate of lead, and other stomach poisons than arsenicals for the use of orchardists and vegetable growers He explained that a large cooperative program of experimental work was being developed between the Bureau and a number of the Entomologists of the State Agricultural Experiment Stations While the situation at present was considered critical, the speaker had no doubt of the timely working out of the problem.

Dr. P. B. DUNBAR, Assistant Chief, Bureau of Chemistry, discussed the problem from the viewpoint of the health of the fruit consumer and fruit grower, not that of a physician. He outlined recent work with various lead arsenate sprays with especial reference to toxic effects, and discussed the cumulative effects of lead stored in the human system in chronic poisoning; also certain economic phases of the problem, including possible foreign embargoes from certain European countries. Consideration also was given to restrictions as to the time of application of sprays in relation to harvesting crops; studies of methods by which fruit could be cleaned after harvesting; the possible use of hydrochloric acid in removing lead-arsenate from apples and pears, and the use commercially of cleaning machinery. At a meeting at Salt Lake City, Utah, after the middle of February the whole situation will be reviewed, including discussion of damages from ill-timed spraying and the use of acid-dipping methods. He considered the outlook as a whole to be quite promising

Dr. B. A. PORTER discussed the plans which have been outlined for a comprehensive reexamination and intensive study of the codling moth problem While it might seem that this problem had been worked threadbare, phases were pointed out where the surface had been not more than scratched, and many others where more intensive study will undoubtedly add further information of value.

Mr. W. H. WHITE called attention to the arsenical residue problem as it affected the control of certain truck crop pests, and directed particular attention to the arsenical residue on celery as a result of attempting to control the celery leaf-tyer (*Phlyctaenia rubigalis*) at Sanford, Fla , by treating with arsenicals. A brief summary of the results of a cooperative project to determine the arsenical residue of celery treated with calcium arsenate both in the form of a spray and a dust was presented. This work indicated that if effective arsenical treatments were applied it would be necessary to wash the treated product to avoid dangerous amounts of arsenic reaching the consumer. Sodium fluosilicate, which had been suggested as a substitute for arsenicals, was being tested as a control for the celery leaf-tyer, and the indications were that this chemical shows promise as a remedy. It was believed that this material, although possibly not as dangerous as the arsenicals to the consumer, was harmful, and in all probability it would be necessary to wash celery treated with it before marketing.

Dr. SIEGLER gave a brief review of experiments in mechanical control now being conducted at the Sligo, Md. laboratory, including chemical treatment of bands with various substances, the use of corrugated paper vs. burlap bands. He considered the chemical treatments most promising.

Dr. CHARLES H. RICHARDSON stated that the laboratory work on the arsenical problem at Washington will consist of the study and preparation of toxic compounds by the Bureau of Chemistry and the determination of their insecticidal value by the Bureau of Entomology. This work naturally divides itself into two parts: An investigation of the toxicity of the arsenic compounds and an investigation of other non-arsenical compounds The investigation of arsenical compounds will extend beyond the present emergency to a thorough study of arsenic compounds that might be used on non-edible crops or in baits where there is no danger of effect upon human health. It offers an opportunity to study more intimately such complexes as the arsenates of iron, aluminum and copper and to investigate the feasibility of using some form of arsenic absorbed on colloidal substances. Special effort will be directed toward the discovery of a substitute for acid lead arsenate because of the prejudice against lead. The study of non-arsenical compounds will probably first resolve itself into an examination of the fluosilicates and fluorides, as these seem now to be the most promising substitutes for the arsenicals. In addition, other groups of inorganic and organic compounds which are thought to have possibilities will be studied. Particular attention will be given to methods of comparing the toxicity of compounds which are to be used as stomach poisons. It is hoped to formulate methods by which insects may be dosed with known quantities of a compound per unit of body weight under controlled temperature and humidity. Attempts will also be made to study tolerance to stomach poisons, and the absorption, storage and elimination of toxic substances by insects.

Dr. McIndoo stressed the undesirability of giving too much publicity to the entire situation.

Mr. Wood discussed methods of application of calcium cyanide in dusting, including comparison of present work with work on chinch bugs in windy weather.

Prof. Cory also directed attention to the bad impression conveyed by too much publicity given to the problem. He also discussed control of Spanish leaf-miner on beets by the use of barium carbonate as reported by a Russian worker and noticed in the Review of Applied Entomology.

Mr. Abott briefly referred to the use of barium carbonate and other chemicals as stomach poisons.

Mr. Barber, at the request of Dr. Frank E. Blaisdell of San Francisco, California, presented a brief paper concerning an unidentified black beetle excavated from the ruins of an Egyptian city dated between 117 and 235 A. D.

Mr. Gahan reported that the Motschulsky types of certain Hymenoptera within the genus *Harmolita* recently had been received by Waterton at the British Museum.

Mr. Rohwer, commenting on Mr. Gahan's note, stated that certain Motschulsky types of beetles had been received by Dr. Arrow at the British Museum. Dr. Arrow's study of these types established the fact that the species found in the eastern part of the United States and previously considered to be *Serica japonica* Mots. should be called *Aserica castenea* Arrow.

Dr. Aldrich reported on a shipment of Muscoid flies from the Museum in Vienna sent to him for study, in which were found a number of old specimens which Dr. Riley had Dr. Coquillett send to Europe many years ago.

J. S. Wade, *Recording Secretary*

391st MEETING

The 391st regular meeting was held March 3, 1927, in Room 43 of the U. S. National Museum. President J. A. Hyslop presided. There were present 18 members and 12 visitors.

On invitation of the president, Dr. Stanislaw Minkiewicz, of the Institute for Agricultural Research, Department of Entomology, Pulaway, Poland, made a brief address expressing his pleasure at being able to attend a meeting of our Society and conveying greetings from the entomological fraternity of his country. He is studying in this country under the auspices of the Rockefeller Foundation, and his itinerary covers travel from Nova Scotia to the Pacific Coast. He will remain in America eight or nine months.

Remarks also were made on invitation by Mr. A. F. Burgess, of the Gypsy Moth Laboratory at Melrose Highlands, Massachusetts. He gave a brief resume of the previous summer's work on his problem, with especial reference to airplane dusting in forest areas. He is much encouraged over the results of the additional season's work along this line, as he feels that methods have been more effectively developed toward practical control. He also discussed a recent report from Mr. Muesenbeck containing data and showing photographs of somewhat comparable work in Germany. Mr. BURGESS stressed the practical value of having our own men become acquainted with work of this kind in foreign lands, as important and valuable information may thus be secured.

Program: Dr. C. A. WEIGEL: *Hot-water bulb sterilisers.* The present restriction governing the entry of Narcissus bulbs from foreign countries requires that all such imported bulbs shall be given the hot-water treatment either at the port of entry or other designated place. This treatment involves the submersion of bulbs in wire baskets or other containers in water ranging in temperature from 110 to 111°F. for a period of not less than 2½ hours. The object of this restriction is to prevent not only the further entry into this country of the three important bulb pests, the Narcissus fly, *Merodon equestris* Fab., the lesser bulb fly, *Eumerus strigatus* Fallen, and the bulb eelworm, *Tylenchus dipsaci* Kuhn, against which the hot-water treatment is supposed to be effective, but also their further dissemination throughout the United States. The author discussed the various types of hot-water sterilisers which have been constructed in this and other countries, giving special attention to the underlying principles involved in the construction of such apparatus, particularly the methods employed in maintaining a constant and uniform temperature of the water throughout the period of treatment.

Discussed by HYSLOP, BURGESS, and HOWARD.

A paper containing a review of the pea aphis problem was presented by W. H. WHITE. A historical account was given of the pea aphis outbreaks and their effect on the pea canning and seed industries. Measures which had been taken to combat the pest were discussed. The paper was supplemented by lantern slides, illustrating various control devices. Discussed by BURGESS, WEIGEL, HOWARD, SIMMONS, HYSLOP, and SNODGRASS.

Dr. HOWARD discussed briefly the phenomenon of phoresy apropos of a recently published paper by Ch. Ferriere.

Mr ROHWER reported the recent receipt from Mr. Bishopp of a Chalcid parasite of screw-worm flies which was studied several years ago and thought to be new species. The present material was referred to Mr. Gahan, who determined it as *Brachymeria fonscolombei* (Dunfoar). The American and European species were found to be the same, and it is fairly common in Europe. He discussed the distribution of some of our parasites, notably those within the genus *Apanteles*, and stressed the need for more study of world-wide material rather than that from a single country.

Mr. HYSLOP reported the receipt recently from Dr. Van Dyke in California of larvae which proved to be those of a typical *Cebrio*. Hitherto, the Cebrionidae have been supposed to occur only east of the Rocky Mountains and the Plastoceridae only west of the mountains.

Dr. HOWARD spoke of the discovery some years ago by Dr. Hooker and Mr. Wood of two Hymenopterous parasites of ticks in Texas for which he founded the genus *Ixodiphagus*, and of the subsequent finding of a European species of this same genus in ticks on deer near Paris, France, He said that the European species had recently been brought to this country and established on the Island of Naushon near Boston and that Dr. Cooley is trying to take the same European parasite to the Bitter Root Valley in Montana in the hope that it will parasitize the Rocky Mountain spotted-fever tick.

Mr. **Barber**, commenting on Mr. Rohwer's remarks gave several examples of the extreme desirability of having more studies of insects from a worldwide viewpoint, and pointing out a number of cases of synonomy which would not have occurred had not the studies been made on a comparatively provincial basis.

J. S. **Wade**, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

In the U. S. Geological Survey the Section of Areal Geology has been combined with the Section of the Geology of Nonmetalliferous Deposits, with G. R. **Mansfield** as Geologist in charge. H. D. **Miser** has been placed in charge of the Section of the Geology of Fuels.

The Italian Government has nominated Dr. **Henry S. Washington**, of the Geophysical Laboratory, Cavaliere of the Order of the Crown of Italy and has decorated him with the Cross of the Order, in recognition of his work on the rocks and volcanoes of Italy.

Dr. A. F. **Foerste**, who for some months has been studying certain groups of Paleozoic cephalopods at the National Museum, has returned to his regular duties as teacher of physics in Steele High School, Dayton, Ohio.

A. S. **Hitchcock** has spent about three months in Washington, Oregon, and northern California, studying the grass flora. Much of the work has been carried on in the National Forests in company with members of the Forest Service investigating range problems.

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MINERALOGY.—*Calcite oolites with pentagonal dodecahedral form.*[1]

EARL V. SHANNON, U. S. National Museum.

The present paper contains a description of some very unusual forms of calcite oolites from Idaho and Japan. The Idaho specimens are from the collection of the late Frederick A. Canfield and those from Japan are in the reference collection of the National Museum. These oolites are regular pentagonal dodecahedra, a geometrical form impossible as a crystal form. It is suggested that they owe their peculiarity to pentagonal dodecahedral packing of the oolites in their original resting place.

The Idaho material (Canfield No. 5801) is labeled "Calcite, Eagle Rock, Idaho; these forms are regular pentagonal dodecahedrons—said to be impossible for crystals. Presented by Dr. F. M. Endlich, who collected them. See Dana page 268." On page 268 of the sixth edition of Dana's *System of Mineralogy* the following reference to the material from this locality appears. "Minute concretionary forms having a spherical concentric structure within and externally the form of a regular pentagonal dodecahedron (not pyritohedron) have been obtained from a calcareous spring near Eagle Rock, Idaho; their form has not been explained." The information given by Dana was doubtless obtained from examination of the same material as that in the Canfield collection, since no reference to these forms has been found elsewhere in the literature. Nothing definite has been learned relative to the occurrence. Eagle Rock is not given on any map or in any gazeteer which has been examined. The specimens were collected by F. M. Endlich, apparently while engaged in work on the Hayden Survey, probably about 1872. In several places in the report for that year mention is made of Eagle Rock or Taylor's Bridge across Snake River, apparently northwest of Ross Fork and probably at or near the site of the present bridge south of Tilden and east of Yuma. There is no mention of the calcite oolites or of any calcareous spring.[3]

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[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received August 31, 1927.

The Canfield material consists of a dozen white and porcellanous-appearing individuals 2 millimeters in diameter. They are almost model pentagonal dodecahedra although the edges are somewhat rounded and some of the faces are curved. They possess sufficient luster to cause most of the faces to yield a visible though faint signal on the goniometer, and the majority of the faces fall in the positions of the planes of the geometric form. Although they naturally suggest pyritohedra to the mineralogist, the edges are all of equal length and the interfacial angles are all the same.

One broken individual was crushed and examined under the microscope. The structure is distinctly concretionary and very finely fibrous spherulitic. The natural tendency to break parallel to the fibrous structure competes with a parting in thin skins parallel to the spherical surface. The spherical flakes are approximately perpendicular to the optic axis of a majority of the aggregated fibers and are largely dark between crossed nicols, but are granular with stippling by grains of higher birefringence. The flakes as a whole give an apparent interference figure which is uniaxial or slightly biaxial with 2E nearly zero and with positive sign. Calcite is optically negative and it would seem that this positive interference figure is anomalous and is due to the fibrous structure—a supposition strengthened by the features of the grains which lie parallel to the fibers showing maximum birefringence, for the elongation of these fibers is negative, and thus contradicts the observed positive interference figure. Measurements of the refractive indices were not satisfactory. Basal flakes yielded for ω the apparent value 1.655, and prismatic flakes gave for ϵ a value considerably above 1.485. The apparent birefringence is thus somewhat lower than that of calcite, but this is doubtless another anomaly due to the structure. No grain large enough to examine was crystallographically a single unit but each was made of an enormous number of individual fibers, only a majority of which were in a position to show the ultimate indices. Where the birefringence is very high, as in calcite, and the material fine grained, a relatively small dilution of the extreme values for the indices by fibers away from the critical position must effect a considerable change in the mass index.

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[3] F. H. BRADLEY, *The Snake River Division* U. S Geol. Geogr. Survey Terr. (Hayden), 6th Ann. Rept, p. 209 1873.

Lacroix[3] has given the name "ktypeite" to pisolitic material from Carlsbad, Bohemia, and Hammam-Meskoutine, Algeria, formerly referred to aragonite and similar in character to the oolites from Idaho. Its specific gravity was given as varying from 2.58 to 2.70, or less than that of calcite. Its birefringence was found to be 0.020 while that of calcite is 0.172. In parallel polarized light a black distorted cross was noted, while portions gave a positive black cross in convergent light Heated to low redness the pisolites decrepitated and finally were "transformed into calcite." "Ktypeite" is quite probably the same as the material here described and owes its apparent deviation from the optical properties of calcite to the intimately fibrous concretionary structure, the relation to calcite being similar to that of chalcedony to quartz.

The most striking and unexplainable feature of the Idaho material being the geometrical form, a search was made through the various collections of the National Museum for other examples of oolites or pisolites exhibiting similar features. The only other samples found (U. S. N. M. Cat. Nos. 47,123 and 86,694) were from Shinano Province, Japan. These consist of some hundreds of pisolites varying from 2 millimeters to 15 millimeters in diameter. The smaller of these are spherical or ellipsoidal in form, and the larger are subangular. Two of the subangular specimens about 10 millimeters in diameter are well defined pentagonal dodecahedra with rounded edges and concave faces.

In an attempt to determine whether the oolites under discussion are aragonite or calcite three of the small spheres from Japan, one of the larger Japanese dodecahedra, three snowy-white and perfectly spherical oolites 2 millimeters in diameter from the "Snake River Hot Springs," Montana, (U. S. N. M. Cat. No. 45,998), one of the Idaho dodecahedra, and a small fragment of "flos ferri" aragonite from Steiermark, Austria, (U. S. N. M. Cat. No. 87,304), were boiled together in dilute cobalt nitrate solution. The dodecahedra from both Idaho and Japan and the spherical oolites from Japan took on the pale blue color of calcite while the "flos ferri" and the Montana oolites showed the deep violet characteristic of aragonite. It seems established that the polyhedral oolites under discussion are calcite.

The writer is informed by Mr. Laurence La Forge that Wirt Tassin found polyhedral oolites in the collections of the Hayden Survey and, after engaging in considerable speculation as to the origin of the unique forms, analyzed them and found them to be pure calcium carbonate. No record of the figures of this analysis can be found nor any of the analyzed sample. The present writer found the material to dissolve completely in cold dilute hydrochloric acid.

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[3] A. LACROIX, Acad. sci. C. R **126**: 602. 1898. See DANA, *Syst. Min*, 6th ed., App. 1, p. 39. 1899.

The internal structure of the dodecahedral forms is that characteristic of radiate-fibrous concretionary oolites—a structure that almost invariably produces a more or less spherical form. Thus the symmetry of the exterior of the oolites cannot be the result of internal structure or forces, and it becomes pertinent to inquire as to what external conditions may have produced the polyhedral forms. The normal explanation in mineralogy for external geometric symmetry which is at variance with internal molecular structure is either pseudomorphism or inversion. In pseudomorphism a previously existing crystal with euhedral boundaries has been converted into another substance by chemical reaction without a change in form. The molecular structure of the second substance bears no relation to the external geometric form inherited from the preceding mineral. In the present case the crystal-like forms are pentagonal dodecahedra, represented in crystallography only by the pyritohedron, so named because it is of frequent occurrence with the minerals of the pyrite group. It is a solid bounded by twelve faces, each of which is a pentagon with four equal sides and one longer side, and closely resembles the regular pentagonal dodecahedron of geometry with regular pentagons as faces. The regular pentagonal dodecahedron is one of the two regular solids of geometry which are impossible in crystallography because they are contrary to the laws of symmetry and rational indices. The ratios of the axial intercepts of a crystal face must be either whole numbers, zero, or infinity, whereas the intercepts of the face of the regular pentagonal dodecahedron in prismatic position are as $1:\frac{1+\sqrt{5}}{2}:0$. The only possible explanation of the origin of the calcite forms in question by pseudomorphism is to assume that they have replaced pyrite crystals bounded by a pyritohedron of high and irrational indices closely approaching the regular pentagonal dodecahedron in angle—an assumption which is highly improbable.

The other cause of lack of correspondence between external crystal form and internal structure, inversion, is illustrated by many minerals of which leucite is a typical example. This mineral, which occurs as isometric trapezohedral crystals of perfect form, is usually biaxial in polarized light under the petrographic microscope and has the properties of a doubly refracting substance. The accepted explanation of this discordance between form and internal structure is that the substance at an elevated temperature has the symmetry represented by the external form, but at ordinary temperatures possesses the symmetry represented by the internal structure. The mineral was formed at high temperature and the external form was determined by that temperature. The internal structure, however, inverted in cooling to that stable at ordinary temperatures. In the case of calcium carbonate there is no high temperature form which approaches isometric symmetry and inversion therefore cannot be invoked as the cause of the form of the unusual oolites.

Since the pentagonal dodecahedral forms cannot be logically explained by changes in internal structure or by pseudomorphism it seems reasonable to investigate the possibility that they are due to forces operating externally. Oolites structurally like those under consideration and more or less spherical in form are frequently formed in calcareous springs and the most perfectly rounded ones are those which are kept more or less continuously in suspension by the rising current of water. Since the Idaho examples are typical oolites structurally, and were formed in a calcareous spring, there is sufficient reason for assuming that they were originally spherical and that the spherical form was subsequently modified by external forces. The most probable force to be considered is the result of mutual interference or crowding and the problem becomes that of the mutual deformation of spheres. If it be assumed that spherical oolites of uniform size and perfect form settled in recesses of the spring and continued to grow at a uniform rate, they must ultimately have reached the point where the surfaces of contact were practically plane. Compression of closely packed plastic spheres would give the same result, were the pressure essentially equal from all directions, but the calcite spherulites are essentially rigid and their deformation can scarcely be attributed to pressure from outside the mass of oolites. It is doubtless due to continued growth by accretion from the calcium carbonate of the spring water.

The natural supposition would be that when uniform spheres have been so modified as to fill space solidly by becoming plane surfaced polyhedra, each polyhedron would be a geometric holohedron and the problem presented for solution would be the classic one of the division of space with minimum partitional area. Were only two dimensions represented the problem would be easily solvable and the solution capable of facile experimental demonstration. Thus a single layer of uniform spheres is easily seen to assume a hexagonal packing and the ideal deformation of cylinders into hexagonal prisms, as classically represented in honeycomb textures, is illustrated by many natural examples. In three dimensional packing the problem is not so simple. The mathematical solution derived as to the angles for stable equilibrium is simply that every angle of meeting of film-surfaces is exactly 120°.[4] The rhombic dodecahedron is a polyhedron of plane sides between which every angle of meeting is 120°. Space can be filled with or divided into equal and similar rhombic dodecahedrons and the rhombic dodecahedron might seem to be the solution of the problem for the case of cells equal in volume and having every part of the boundary of the group either infinitely distant from the place considered or so adjusted as not to interfere with the homogeneous interior distribution of the cells. The rhombic dodecahedron is the only plane-sided polyhedron which presents a solution of the equilibrium problem. Lord Kelvin concluded from theoretical considerations, however, that, as found by Plateau by experimentation with soap films, the angles of the rhombic dodecahedron, giving when space is divided into such figures twelve plane faces meeting at a point, are essentially unstable. He concluded that the requirements of stability are best fulfilled when the rhombic dodecahedron is so divided by insertion of planes that the unit becomes what he calls a minimal tetrakaidecahedron or an isotropic tetrakaidecahedron, familiar to crystallographers as a cuboctahedron, having curved arcs of 19° 28′ for its edges.

Desch[5] has critically considered this problem from the standpoint of the metallurgist with the view of determining and explaining the forms of the crystal grains in solidified metals. According to the hypothesis of Quincke, metals and other substances, immediately before solidification from the liquid state, separate into two immiscible liquids, one in much smaller quantity than the other. These liquids have interfacial surface tension and a foam is formed, the liquid present in smaller proportion arranging itself in cell walls and the other constituting the cell contents. Crystallization then takes place within the cells and the cell walls are represented in the solid mass by the boundaries of the crystal grains. If this hypothesis is correct the grains in a solidified metal should approximate the form of cells of a foam and these, according to Kelvin, should be cuboctahedra[6] with curved edges. Desch experimented with masses of foam and obtained a certain proportion of cells having the cuboctahedral form. By far a greater number, however, had the five sided faces characteristic of the pentagonal dodecahedron. He then proceeded to the examination of the form of the grains in beta brass. This brass containing aluminum was made to separate into its individual grains by immersion in mercury. In this also the majority of faces were five sided and the form of most of the grains seemed to approach the pentagonal dodecahedron.

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[4] Sir William Thomson (Lord Kelvin), *On the division of space with minimum partitional area* Phil. Mag. 24: 503–514. 1887.

[5] Cecil H. Desch, *The solidification of metals from the liquid state.* Jour. Inst. Metals 22: 241–263. 1919.

The writer confirmed the observations of Desch on the cells of a foam. A large mass of fairly uniform bubbles was produced in a closed vessel by slowly blowing air at constant low pressure through a fine capillary tube. By observing the reflections of light from the contact surfaces of the interior of the mass it was found that a considerable majority of the faces were of pentagonal outline and that the cells approximated the form of the regular pentagonal dodecahedron. A much smaller proportion showed four and six sided faces, confirming the presence of Kelvin's cuboctahedral cell. The latter is further confirmed by the practical absence of anything recognizable as a rhombic dodecahedral cell.

Since the problem was considered as one of interfering spheres, a number of equal spherical masses of plastic modeling clay about 1 centimeter in diameter were packed in a spherical space and subjected to, as nearly as possible, equal pressure from all directions. When the masses of clay were separated and examined, the interior units had become polyhedra and a considerable majority of them showed five sided faces.

In packing uniform spheres to fill space there are two extremes of compactness of the group. Thus the loosest packing is six-contact packing, that is, any sphere taken as a nucleus is in contact with six other spheres. Compression of such a group would result in the nuclear sphere assuming a cubic form. On the other hand, the closest possible packing is twelve-contact packing, in which each nucleus of the group is in contact with twelve other spheres. There are three convenient ways in which twelve spheres may be brought into contact with the central sphere. First, six units may be arranged around the circumference in a plane with the nucleus, and a triangular group of three placed above and three below. Crystallographically considered the equatorial spheres would yield faces, if the spheres were forced together, in the position of a hexagonal prism with a trigonal pyramid above and below. This may consequently be referred to as the hexagonal-trigonal packing. The second grouping may be constructed with four spheres placed below the nucleus, four above, and four around the equator. By compression such an aggregate will yield a rhombic dodecahedron and such packing is called rhombic dodecahedral packing. In the third arrangement five spheres form a ring above the equatorial plane of the nucleus and five below, offset so as to occupy the interstices of the upper five. One sphere at the top and one at the bottom completes the group. This group, upon compression, gives a regular pentagonal dodecahedron as the nucleus and may be called pentagonal dodecahedral packing.

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[6] The term cuboctahedral is here used in preference to tetrakaidecahedral because crystallographers are more familiar with it. It is to be understood that the tetrakaidecahedron of Kelvin is a simple cuboctahedron or octahedron evenly truncated by the faces of the cube so that all edges are of equal length. This yields a fourteen-faced solid in which six of the faces are squares and eight are regular hexagons.

The faces formed upon any sphere, considered as a nucleus of a homogeneous group, by continued uniform growth or by compression must obviously obey the law which requires that the planes of contact be at right angles to the lines joining the centers of the spheres. In the case of rigid spherulitic oolites of calcium carbonate, all growing outward at a uniform rate, the form attained must be polyhedral and governed entirely by the initial position of the oolites with reference to one another. Assuming a close packing there would be a twelve-contact arrangement and the resultant polyhedra must be either pentagonal dodecahedra, rhombic dodecahedra or the hexagonal trigonal form mentioned above. The cuboctahedron, the minimal form, could not arise because it would require fourteen point packing of the original spheres, which is impossible.

The pentagonal dodecahedral forms under discussion may then be reasonably interpreted by assuming a pentagonal dodecahedral packing of the oolites in their original resting place. The fact that the pentagonal dodecahedron is the form which actually occurs suggests that the corresponding packing is most easily assumed, a suggestion further supported by the experiment wherein numerous plastic spheres were packed and compressed. To test the suggestion further a large number of ordinary uniform-sized shot were placed in a round bottomed vessel, shaken until settled and cemented with heated wax. Upon dissection of this mass of spheres, the great majority seemed to be packed in pentagonal arrangement. The experiments with masses of foam, both by Desch and by the writer are also in agreement. There is an essential difference in the behaviour of foams, however, since the spheres of foam are more mobile, are capable of greater movement and deformation and of subdivision, and are more sharply dependent upon surface tension. It is very likely, though, from the large number which approach pentagonal symmetry that the normal packing is pentagonal. The fact that no rhombic dodecahedral foam cells are noted substantiates the ideas of Kelvin, but it is also true that every instance of rhombic dodecahedral twelve-point packing must result in the formation of cuboctahedral cells in a foam. The relative scarcity of cells of this form further argues as to the greater stability of the pentagonal dodecahedral packing. The foam cells behave to a remarkable degree like rigid spheres, even to an appreciable deviation from the theoretical angle of stability demonstrated by Plateau in his study of foam films on a wire framework.

The case of metals especially concerned in the work of Desch is a little harder to understand. The coincidence of the pentagonal structure of the granular metal with that of foam is apparently a substantiation of the Quincke hypothesis. In a homogeneous cooling metal-fusion one would expect the solidification outward from nuclei in a spherical front, and in ideal cases, wherein the temperature was homogeneously distributed, these nuclei might be expected to be very equally spaced. Except by means of the foam hypothesis of Quincke, it is difficult to account for the preference shown for a pentagonal packing.

The calcite oolites examined in the Idaho lot are without doubt selected, ideally perfect examples which may represent the concentration of hundreds or thousands of less perfect or variously bounded individuals. Their form is of extreme interest and it is highly desirable that the locality be visited and a large number of these unusual forms collected as well as studied in place. The explanation of their form above set forth seems the most rational one to fit the facts of the case, but further study of the problem would seem to be highly desirable.

PALEONTOLOGY.—*The generic characters of* Astartella *Hall.*[1]

GEORGE H. GIRTY, U. S. Geological Survey. (Communicated by J. B. REESIDE, JR.)

The genus *Astartella* was established by James Hall in 1858. The only species referred to it at that time was *A. vera* which consequently

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[1] Published by permission of the Director of the U. S. Geological Survey. Received August 31, 1927.

is the genotype. The original description, which is very brief, runs as follows:

> Shell bivalve, thick, smooth or concentrically furrowed: lunule impressed; ligament external; hinge teeth two in each valve, the anterior tooth of the right valve large and strong, with a longitudinal pit in the summit. Related to *Astarte*.

This diagnosis has, so far as I am aware, never been revised or rewritten up to the present time; yet on attempting to verify it from specimens in my collection I found it far from complete and in some respects inaccurate.

The astartellas are one of the commonest pelecypods of our Pennsylvanian faunas and if we except a few species which appear to be isolated because perhaps they are rare, but which may be brought into close relationship when more is known about them, all the species or at least all the more common species are pretty much alike. In any collection of considerable size several species might be distinguished on selected specimens, all of them, however, connected by other specimens of intermediate character. With the astartellas, then, the question is not whether they represent more than a single genus so much as whether they represent more than a single species. The specimens upon which my observations were made therefore unquestionably belong to Hall's genus. I have identified them with *Astartella concentrica* Conrad although it is by no means certain that Conrad's species and the type species of *Astartella* are not the same. *Astartella concentrica* had been in the literature some fifteen years when *A. vera* was described, but it was cited under the genus *Nuculites* and was evidently unknown to Hall.

Although shells of this type constitute one of the most common of Pennsylvanian pelecypods, they rarely show characters of prime generic importance. If they are not actually broken in that part, the hinge margin is liable to be covered by hard rock. Or, as often happens, thanks to the hinge teeth and perhaps also to the marginal denticles, the two valves occur together so that one of them is concealed by the other. To be sure, the shape of these shells is in a measure characteristic and also the sculpture of widely spaced concentric lamellae, although Hall in the original description does say—I suspect with an eye to the off chance—that the shell is smooth or concentrically furrowed. In further comment upon his diagnosis, the right valve is the only one whose interior was figured by Hall and, if judgment is permitted from certain expressions used, it was the only one known to him. It seems doubtful, as will be shown later, whether either valve actually does have two "hinge teeth," by which expression it is fairly certain Hall meant cardinal teeth.

The hinge teeth, as just remarked, are rarely to be seen in these shells, but one of the other generic characters, the "external ligament" (or at least its receptacle), is a conspicuous feature in any specimen that is even fairly well preserved. By that designation Hall undoubtedly had in mind a sharply defined bevelled surface behind the beaks which corresponds to a similar though smaller surface anterior to them which Hall calls the "lunule." On most specimens these two structures show no material difference except in size, and when I have had occasion to refer to the posterior one I have called it an escutcheon. The same term was employed by Meek in describing *Astartella newberryi*. It may actually have been a ligamental area as Hall considered it; nevertheless, my specimens seem to show another structure on the interior of the shell which was apparently a place of ligamental attachment, and although this fact, even if established, might not necessarily prove that the external structure did not also function in the ligamental equipment, it would tend to discredit Hall's interpretation.

Hall's description, I believe, was predicated largely if not wholly upon the right valve. In my collection left valves showing the hinge are decidedly more numerous than right valves. They show that this valve was equipped with a single prominent cardinal tooth which had a large, deep pit or socket on the anterior side. On the posterior side the cardinal tooth is confluent with a thickening of the hinge margin or sort of hinge plate from which it rises considerably, but by no means as much or as abruptly as it rises from the deeply excavated socket in front of it. The shell on the anterior side of the socket is as high and prominent as the cardinal tooth itself; it is probably to be considered a lateral tooth, though it is merely the shell margin which as it recedes, forms the broad, sharply defined lunule.

The hinge structure of the right valve, as already noted, is not shown by as many specimens as the left valve, but it is shown very well indeed by one of them. This specimen has a single large wedge-shaped cardinal tooth that is flat on top and slightly indented by two longitudinal grooves. The tooth has a deep triangular socket on the posterior side; on the anterior side it descends vertically, but not quite so far, and is continuous with a narrow shelf-like projection that is carried forward almost to the anterior extremity of the shell.

This, the anterior prolongation of the hinge-plate, is guarded on its outer or upper side by the thin, strongly projecting edge of the escutcheon, and as its inner edge also is elevated, a short groove is inclosed between them.

But little difficulty is experienced in correlating the structures of the two valves. The flat-topped denticle in the right valve evidently fits into the deep pit that is anterior to the cardinal tooth of the left valve, while the cardinal tooth of the left valve is received by the deep pit that is posterior to the cardinal tooth of the right valve. Thus I recognize but a single cardinal tooth in each valve instead of two. Nevertheless, it is possible to harmonize my observations in some measure with those of Hall, for a slight prominence exists posterior to the socket of the right valve where Hall has figured a posterior cardinal tooth. His figure, however, is not accurate; at least it is not in accord with my observations, and I should hardly regard this elevation as being a tooth. The structure in this part is peculiar and will be considered more in detail farther on. Hall's figure shows two other structures that are really important, although, inasmuch as he did not have the left valve to compare them with, he failed to recognize their significance. His figure shows, though not clearly, a groove passing down the anterior side of the shell margin for a short distance. Actually, as has just been described, this margin is thickened into a narrow shelf that extends forward almost to the anterior extremity, and this shelf-like structure bears a groove along its upper surface by reason of its raised margins. Hall's figure also shows quite clearly a projecting lamina back of the beak which is really the margin of the shell along what he calls the ligamental area.

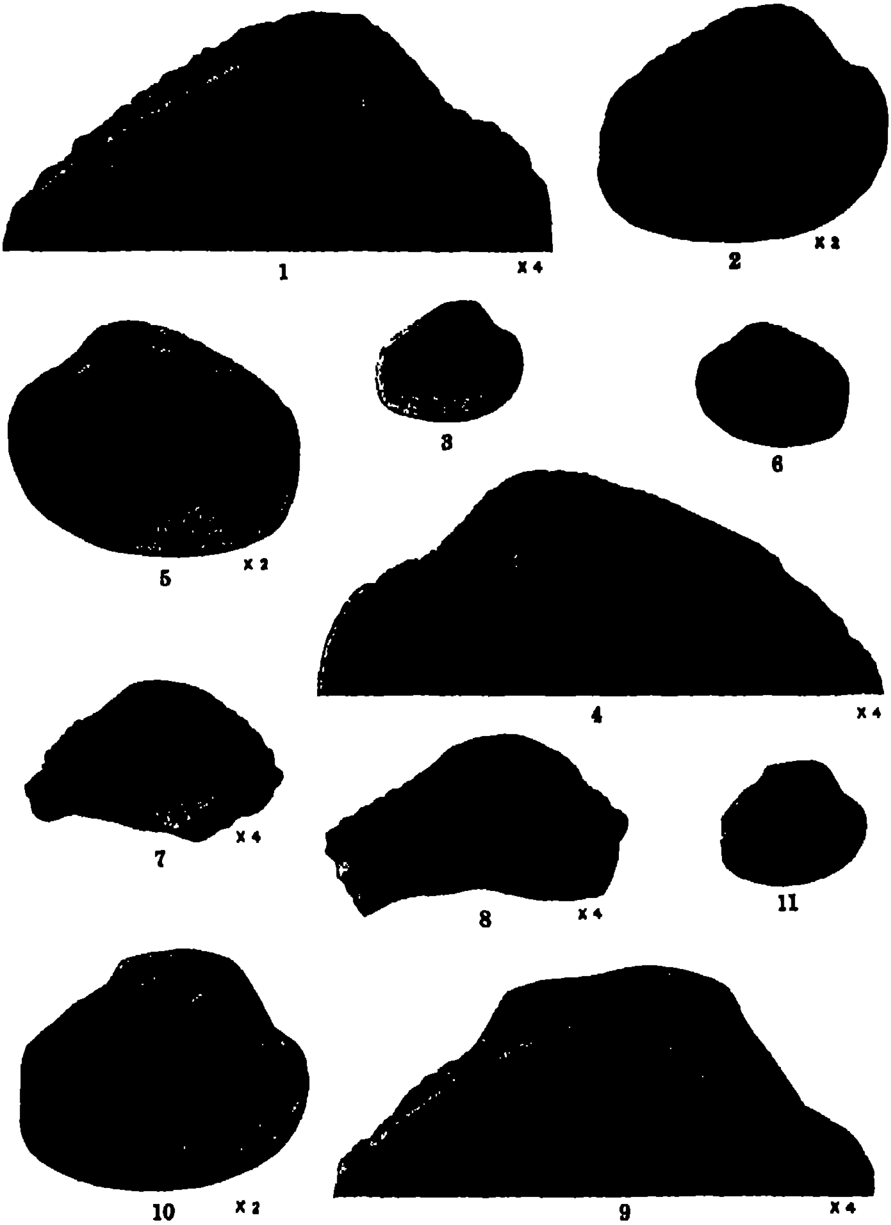
The construction of the left valve is just the reverse of this for the shell is thickened along the posterior margin of the hinge line and grooved to receive the sharp and projecting edge of the right valve, while the shell margin in front of the beak is, as already described, sharp and projecting so as to fit into the groove of the right valve corresponding to it. Whether this reciprocating structure of the two valves would properly be called teeth, I am not sure. In each case one "tooth" seems to be merely the shell margin and not an independent structure comparable to the cardinal teeth.

I must now try to make clear the singular construction of the hinge where in the right valve Hall thought he recognized a posterior cardinal tooth. At this point there is constructed a flat-lying plate approximately parallel to the hinge plate proper, but free above and connected with it only at the lower side. This plate incloses a very narrow, very deep cleft or crack as if part of the shell had been incompletely sawed off from above. In other language, this structure begins as a narrow groove under the beak which rapidly becomes deeper though not broader so as to detach from above a laminar projection that lies almost flat and is but slightly separated from the main body of the hinge plate. To the reader the thought would probably suggest itself that this is some appearance due to accident, but it is very clearly shown and is quite persistent on both valves and in a number of specimens. This plate helps to form what appears to be a receptacle for the ligament, for there is a well-defined striated area partly underneath the plate and partly visible beyond it on the posterior side which I would say was a place of ligamental attachment. The lower boundary of this ligamental area was a continuation of the lower margin of the lamina where it joins the hinge plate; the upper boundary is a distinct angular ridge which forms the lower margin of the escutcheon. Posteriorly this ligamental area narrows strongly from below upward, giving place to the structure which may be called the posterior lateral tooth.

The somewhat remarkable structure which I have tried to describe must, I think, be a place of ligamental attachment. It can have nothing to do with dentition though a slight elevation of the surface more or less incidental to it was apparently identified by Hall as a posterior cardinal tooth. In this respect the two valves are alike and the lamellae could not possibly have interlocked. In so far as one may venture the word, this structure must have served for the attachment either of a muscle or of a ligament, and one can scarcely question that it was for the latter. As I have already remarked, this would not preclude the interpretation of the "escutcheon" as a ligamental area, but it would render the interpretation less probable.

The escutcheon also begins under the umbo above the ligamental groove. It regularly widens posteriorly but is sharply defined below by a ridge and is distinctly an external character.

One more feature, somewhat trivial perhaps, may be mentioned. The dental socket does not itself extend to the umbo, but it is represented upon the plane of the lunule by a triangular structure similar in appearance to the pseudodeltidium of certain brachiopods and formed apparently by shell that filled in (or possibly overarched) the socket as the tooth of the other valve moved forward or was worn off at the upper end. This structure is sharply defined by grooves and is convex, especially on the posterior side. It may be concave on the anterior.



Figures 1–11, *Astartella concentrica* Conrad. 1–3, left valve, ×4, ×2, and ×1. 4–6, right valve, ×4, ×2, and ×1. 7, fragment of a left valve tilted to show the covering of the dental socket and its track, ×4. 8, another fragment of a left valve, ×4. 9–11, left valve, ×4, ×2, and ×1.

Lawrence shale, Iatan and St. Joseph, Missouri.

To summarize the structure of this genus as shown by my specimens, each valve has a single large cardinal tooth, the cardinal tooth of the right valve being anterior to that of the left valve when the two valves were joined. The left valve, consequently, has a deep pit or socket on the anterior side of the tooth, while the right valve has a socket on the posterior side of the tooth. In addition the anterior part of the cardinal margin in the left valve forms a linear tooth that is received by a groove in the thickened anterior margin of the right valve. On the other hand, the posterior part of the cardinal margin in the right valve forms a linear tooth that rests in a groove in the thick posterior margin of the left valve corresponding to it. Between the cardinal tooth and the posterior tooth in each valve is an area of ligamental attachment partly inclosed by a leaflike plate which is continuous below with the main hinge structure. The sharply defined areas on the exterior of the shell are lunule and escutcheon, although the posterior one may have housed a ligament as Hall originally thought.

The muscular imprints consist of a rather large, deep, and sharply defined scar at the anterior extremity of the shell, and another somewhat larger, but less deep and less sharply defined, opposite to it on the posterior superior angle. The pallial line connecting these imprints is indistinct in all the specimens seen, but it appears to be without a sinus, as indeed, has generally been believed. A short distance back of the upper margin of the anterior scar and excavated in the underside of the hinge plate is a small but rather deep pedal scar.

BOTANY.—*New passionflowers from South America and Mexico.*[1]

ELLSWORTH P. KILLIP, U. S. National Museum.

In preparing a revision of American Passifloraceae the writer has had the opportunity of examining the collections of several herbaria in the United States and Europe. As this revision will not be ready for publication for some time the new species recently noted are here described in advance. Photographs of the type specimens in other herbaria are deposited in the United States National Herbarium.

Passiflora stellata Moritz, sp. nov.

Stem slender, subtriangular, striate, finely pilosulous; stipules setaceous, 5 mm. long; petioles up to 3 cm. long, biglandular at base of blade, the glands 0.5 mm. long; leaves 4 to 6.5 cm. long, 4 to 8 cm. wide, 3-lobed about

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[1] Published by permission of the Acting Secretary of the Smithsonian Institution Received August 13, 1927.

one-third their length (lobes broadly triangular or triangular-ovate, 2 to 3 cm. wide, acute or obtusish), subtruncate at base, 5-nerved, entire at margin, sparsely and minutely pubescent above, more densely pubescent beneath, membranous; peduncles about 2.5 cm. long; bracts setaceous, scattered; flowers white or greenish (?); sepals oblong, about 2 cm. long, hyaline at margin, cucullate at apex, keeled, the keel terminating in a horn 3 mm. long; petals linear, less than 1 cm. long, obtuse, white, membranous; corona filaments in a single series, liguliform, about 7 mm. long; operculum membranous, 7 mm. high, slightly plicate, erose at margin, white; gynophore slender, striate, slightly swollen at base, stamens very slender, 1 cm. long; ovary ellipsoidal, 6-grooved, glabrous.

Type in the herbarium of the Muséum d'Histoire Naturelle, Paris, collected "in reg temp. et subfrig.," New Grenada (Venezuela?), in 1852, by M. Moritz (no. 1961). Duplicate in the British Museum.

This is quite distinct from any known species. The shape of the leaves and the presence of glands at the apex of the petioles indicate a relationship with *P. warmingii*. The stipules, however, are setaceous, not foliaceous; the faucial corona consists of a single, not a double, series of filaments; the gynophore is more slender; and the ovary ellipsoidal, not ovoid.

Passiflora quadriflora Killip, sp. nov.

Plant glabrous throughout, stem angular, strongly compressed, striate, scabrous; stipules setaceous, about 1 cm long; petioles 7 to 9 mm. long, tortuous, glandless, leaves narrowly lanceolate, 5 to 8 cm. long, 1.5 to 2 cm. wide, unlobed, acute, mucronulate, rounded or subcuneate at base, entire, 3-nerved (nerves nearly parallel, conspicuous), reticulate-veined, ocellate between lateral nerves and midnerve, coriaceous or subcoriaceous; peduncles in pairs, 2-flowered, the main portion and the branches nearly equal, each about 1 cm long; bracts setaceous, 3 to 5 cm. long, scattered; flowers rotate-campanulate, about 5 cm. wide, greenish (?); sepals lanceolate, about 2 cm. long, 0.5 cm. wide at base, acute; petals linear-lanceolate, 5 to 6 mm. long, 1 to 1 2 mm wide, obtuse, white, membranous; corona filaments in two series, the outer filiform, 5 to 6 mm. long, the inner series capillary, 2 mm. long, operculum membranous, 2 mm. long, slightly plicate, finely fimbriate one-third its length; nectary ring annular; limen shallowly saucer-shaped, 0.5 mm. high; ovary globose; styles very slender, about 8 mm. long.

Type in the herbarium in the Field Museum of Natural History, no. 536227, collected at Villcabamba, hacienda on the Río Chinchao, Peru, altitude about 1900 meters, July 17 to 25, 1923, by J. F. Macbride (no. 5189). A specimen of this collection is also in the U. S. National Herbarium.

This species presents several unusual characters. The peduncles are 2-flowered, but they do not terminate in a tendril as in the case of *P. cirrhiflora*, *P. tryphostemmatoides*, and *P. gracillima*. The leaves are unlobed, an unusual form in the subgenus *Plectostemma*, to which the species clearly belongs. The operculum, in addition, is more conspicuously fimbriate than in most species of this subgenus.

Passiflora goniosperma Killip, sp. nov.

Plant densely pilose-hirsutulous throughout, the hairs of the stem often recurved or retrorse; stem subtriangular, tortuous; stipules linear-lanceolate, 4 to 6 mm. long, up to 1 mm. wide, aristate, subfalcate; petioles 5 mm. long or less, glandless; leaves oblong in general outline, 2-lobed one-quarter to one-third their length, 1.5 to 4.5 cm. along mid-nerve, 2 to 6 cm. along lateral nerves, 2 to 4 cm. between tips of lobes (lobes obtuse, mucronulate, the sinus truncate or slightly rounded, occasionally emarginate, often mucronulate at end of midnerve), scaberulous and densely hirsute above with subappressed white hairs which are enlarged at base, usually pilose-hirsute and paler beneath; flowers in pairs on short (2 cm.), axillary, leafy branches, rarely on the main stem; bracts none; sepals lanceolate, about 7 mm. long, 2 mm. wide, acute, hirsutulous without; petals narrowly linear, 3 to 4 mm. long, 1 mm. wide; corona filaments in a single series, liguliform, 2 mm. long; operculum membranous, closely plicate, white; limen annular; ovary ovoid, longitudinally 6-grooved, white-puberulent; fruit asymmetrically ellipsoidal, up to 4 cm. long and about 1 cm. wide, sharply 6-angled, long-tapering at ends; seeds obovate, 3 to 4 mm. long, 1 5 to 2 mm. wide, blackish, lustrous, narrowed at both ends, the axis more or less curved, the lateral margins thin-winged, the central portion of each face elevated, forming a sharp-toothed ridge (hence the seed quadrangular in cross-section).

Type in the Universitetets Botaniske Museum, Copenhagen, collected at Niña de Dolores, (Oaxaca?), Mexico, August, 1842, by Frederik Liebmann (no 4076; *Passiflora* no. 29).

OAXACA: Santa Gertrudis, *Liebmann* 4075, *Passiflora* no 30 (Copenhagen). Sierra de Ixthlán, *Conzatti* in 1913 (U S. N. M , Gray Herbarium), in 1918 (Missouri Botanical Garden).

The seeds of *P. goniosperma* differ markedly from those of other American species of *Passiflora.* Each of the two faces has the appearance of being compressed laterally to form a narrow longitudinal ridge; the transverse ridges, normally extending from margin to margin in the species of the subgenus *Plectostemma* with sulcate seeds, are reduced to a row of teeth along this longitudinal ridge. The ellipsoidal, 6-angled fruit, the absence of bracts, and the general aspect of the plant, however, show a rather close relationship with *P. capsularis*, the species to which the type specimen of *P. goniosperma* was referred by Masters. In addition to the seed characters, other marks which distinguish it from *P. capsularis* are the smaller leaves, with rounded subparallel lobes (lobes usually acute, divergent in *P. capsularis*).

Passiflora conzattiana Killip, sp. nov.

Stem slender, terete, pilosulous, becoming glabrate, reddish; stipules setaceous, about 4 mm. long; petioles densely pilosulous, 0 8 to 2 cm. long, glandless; leaves 2 to 5 cm. long, 3 to 8 cm. broad, 2-lobed (lobes acute, rarely obtusish, widely divergent, the sinus shallowly semilunate or the upper margin nearly truncate), entire, cordate at base, 3-nerved (nerves often terminating in a short cusp), thin, sparingly setose above, densely pubescent beneath; peduncles solitary or in pairs, slender, up to 2 cm. long; bracts none; flowers small, 1 to 2 cm. wide; sepals linear-lanceolate, 3-nerved, sparingly pilose without, glabrous within, 8 to 10 mm. long, 2 mm. broad, petals linear-lanceolate, 4 to 5 mm. long, 1.5 mm. broad; corona filaments in a single series, relatively few, liguliform, 3 to 4 mm. long, 0 4 mm. broad, deep red; operculum membranous, erect, closely plicate, red below, pale yellow or white above, the margin minutely fimbrillate; limen annular; gynophore glabrous, 4 to 5 mm. long; anthers oblong, 3 mm. long, 1 mm. broad; ovary narrowly ovoid, densely puberulent or tomentulose; styles clavate, 3 mm. long; stigma globose, 0.8 mm. in diameter; fruit narrowly ellipsoidal, about 5 cm. long (including the long slender stipe and the caudate tip), 1 cm. wide, 6-angled, finely pubescent, at length glabrous; seeds broadly obcordate or suborbicular, 1.5 to 2 mm. long and wide, transversely 5 or 6-grooved, the ridges smooth.

Type in the U. S. National Herbarium, no. 1,206,806, collected at Mirador, Veracruz, Mexico, June, 1921, by C. A. Purpus (no. 8804).

SAN LUIS POTOSÍ: Las Canoas, *Pringle* 3638 (Gray Herbarium).

VERACRUZ: Near Jalapa, *Rose & Hough* 4260 (U. S. N. M.), 4938 (U. S. N. M.), 7840 (U. S. N. M.). Totula, *Liebmann* 4154, *Passiflora* 28 (Copenhagen).

The principal points of difference between this species and *P. capsularis* and *P. rubra* are much smaller flowers, smaller leaves nearly truncate at the upper margin, nearly orbicular, rather than oblong, seeds. Several of the specimens here cited were distributed as *P. rubra*, a species frequent in the West Indies and South America but apparently not found in Mexico.

Passiflora urbaniana Killip, sp. nov.

Plant scandent, with slender tendrils; stem terete, softly ferruginous-villosulous or almost tomentose toward end; stipules minute, semiannular about stem, barely 0.5 mm long; petioles 5 to 10 mm. long, slightly dilated at base, glandless, densely ferruginous-tomentose; leaves oblong or lance-oblong, 4.5 to 8 cm long, 2 to 4 cm. wide, obtuse or rounded at apex, entire or remotely undulate-serrulate, 3- (or 5-)nerved (nerves impressed at base, the lateral not reaching to middle of margin, the secondary nerves 5 to 7 on each side), subcoriaceous, minutely hispidulous above, densely and softly ferruginous-tomentose beneath; peduncles 5 to 8 cm. long, pilosulous; bracts 2 to 2.5 cm long, 1 to 1.5 cm wide, viscous, deeply bipinnatisect, the segments gland-tipped; flowers about 5 cm. wide, the tube short-campanulate, hirsutulous without, sepals oblong, about 2 cm. long, 0.6 cm. wide, obtuse, greenish and hirsutulous without, 3-nerved, the middle nerve becoming carinate toward apex, and terminating in a short horn; petals linear, slightly shorter than the sepals, lavender; corona filaments in 5 series, those of the two outer filiform, about 1.3 cm long, violet at base, radiate, those of the inner series almost capillary, about 2 mm. long, erect; operculum membranous, erect, about 1 mm high, non-plicate, minutely denticulate, limen similar to operculum, about 2 mm. high; ovary subglobose, densely white-villous-tomentose.

Type in the U S. National Herbarium, no. 529493, collected at Sanitago de las Vegas, Province of Havana, Cuba, where cultivated, May, 1906. (Herbarium de Cuba, Estación Central Agronómica no. 2588.) Said to have been grown from seeds from Belize, British Honduras. Specimens of this collection have been seen in the New York Botanical Garden, the Gray Herbarium, and the Berlin Botanical Garden.

This is a most unusual species, and it is unfortunate that its precise origin is uncertain. The bracts and flower structure show that it belongs to the subgenus *Dysosmia*, of which the only other species with entire oblong leaves is the Brazilian *P. clathrata*. That is an erect, suffrutescent plant with very short peduncles and a wholly different indument. The leaves are very similar in shape and size to those of *P. multiflora*, a native of the West Indies, belonging to a wholly different group of *Passiflora*. There is a bare possibility that this may be a hybrid of *P. multiflora* and some species of the *Dysosmia* group, perhaps *P. foetida*.

This new species is named for Dr. I. Urban, the eminent student of the flora of the West Indies, whose assistance to me at Berlin is highly appreciated.

Passiflora mesadenia Killip, sp. nov.

Stem subquandrangular, striate, pilosulous; stipules subreniform, 1.5 to 2 cm. long, 0.5 to 0.8 cm. wide, aristate, glandular-dentate near base; petioles up to 2 cm long, 2 or 3-glandular at middle, the glands short-stipitate, about 2 mm. long and 1 mm in diameter; leaves 4 to 6 cm. long, 6 to 8 cm. wide, 3-lobed to middle (lobes acute, the middle lobe oblong-lanceolate, the lateral lobes ovate-lanceolate), subauriculate at base (basal lobes slightly overlapping), shallowly and irregularly dentate-serrate, 5-nerved, reticulate-veined (nerves and veins impressed above), subcoriaceous, dark green and glabrous above, paler and pilosulous on the nerves and veins beneath; peduncles solitary, up to 5 cm long, subquadrangular, stout; bracts 4 to 5 cm. long, acute, united about half their length, glabrous; flower-tube cylindric, 7 to 8 cm. long, about 1 cm in diameter, pink without, glabrous; sepals oblong, about 4 cm. long, 1 cm. wide, obtuse, concave toward apex, short-awned on outside just below apex, pink without, white within; petals oblong-spatulate, as long as the sepals, about 1.5 cm wide, obtuse, white; corona reduced to a row of small thick tubercles about 1 mm long; operculum 5 to 6 mm. long, the margin recurved, denticulate; limen closely surrounding base of gynophore, lobulate; ovary narrowly ovoid, glabrous, pruinose.

Type in the herbarium of the Field Museum of Natural History, no. 536001, collected at Villcabamba, hacienda on the Río Chinchao, Peru, altitude about 1800 meters, July 17–26, 1923, by J. F. Macbride (no. 4960).

This species differs from *P. macrochlamys*, a near relative, in the conspicuous petiolar glands, borne near the middle of the petiole, auriculate leaf-bases, much smaller stipules, and longer flower tubes.

Passiflora roseorum Killip, sp. nov.

Stem angular, striate, densely tomentulous; stipules oblong, 1.5 cm. long, 8 to 9 mm. wide, oblique and subcordate at base, fimbriate-dentate, the teeth 2 to 3 mm. long, not gland-tipped; petioles up to 1.5 cm. long, bearing 2 or 3 rudimentary glands, or glandless; leaves 3.5 to 4 cm long, 4.5 to 5 cm. wide, 3-lobed (lobes triangular-ovate or suborbicular, 1.5 to 2 cm. wide, rounded at apex, the angle at sinus between middle and lateral lobes about 90°), truncate at base, 5-nerved, glandular-serrulate, thick-coriaceous, glabrous and sublustrous above, densely brown-tomentose beneath, the nerves and veins impressed above; peduncles up to 5 cm. long; bracts 4 cm. long, united two-thirds their length (free portions ovate-lanceolate, about 1.5 cm. wide, abruptly acuminate), puberulent without, tomentose within; flowers violet, the tube cylindric, 7 to 8 cm. long; sepals oblong, about 3 cm. long, 1.5 cm. wide, obtuse, minutely awned on outside just below apex; petals subequaling the sepals, obtuse; corona reduced to a deeply crenulate ring, scarcely tuberculate; operculum dependent, the margin recurved, subentire; gynophore slender, not exserted; ovary obovoid, glabrous.

Type in the U. S. National Herbarium, no. 1,022,682, collected in the vicinity of Zaragura, Ecuador, September 28, 1918, by J. N. Rose, A. Pachano, and George Rose (no 23154).

This may be a hybrid between *P. jamesoni* and *P. ecuadorica*, the fringed stipules suggesting the former and the small, shallowly lobed leaves the latter. Unlike either of these the under surfaces of the leaves and the involucre are covered with a dense brownish tomentum.

Passiflora anastomosans (Lam.) Killip.

Tacsonia anastomosans Lam. in DC. Prodr. 3: 335. 1828.

Passiflora acutissima Killip.

Tacsonia lanceolata Mast. in Mart. Fl. Bras. 13^1: 536. 1872.
Passiflora lanceolata Harms, Bot. Jahrb. Engler 18: Beibl. 46: 11. 1894, not *Passiflora lanceolata* G. Don (1834).

Passiflora matthewsii (Mast.) Killip.

Tacsonia matthewsii Mast. in Mart. Fl. Bras. 13^1: 539. 1872.

Passiflora urceolata (Mast.) Killip.

Tacsonia urceolata Mast. in Mart. Fl. Bras. 13^1: 539. 1872.

Passiflora paulensis Killip, sp. nov.

Plant glabrous throughout; stem terete, striate; stipules subreniform, 0.7 to 1.5 cm. long, 2 to 2.5 cm wide, cuspidate, crenulate to subentire, membranous; petioles slender, up to 2 cm. long, 2 to 4-glandular, the glands stipitate, up to 1 mm. long; leaves ovate-oblong or oblong-lanceolate, 5 to 7 cm. long, 3 to 4 cm. wide, acute, rounded and subpeltate at base, entire, subtripli- or quintuplinerved, arcuate-veined, membranous; peduncles slender, up to 3.5 cm. long; bracts cordate-ovate, 2 to 2.5 cm. long, 1 to 1.5 cm. wide, acute, conspicuously reticulate-veined, chartaceous, pinkish when dry; flower-tube broadly campanulate, ventricose at base, sepals oblong, about 2.5 cm. long, 1 cm. wide, obtuse, cucullate; petals oblong-spatulate, slightly longer than sepals, obtuse; corona filaments in 5 series, the two outer 2 to 2.5 cm long, terete, fasciate, those of the two succeeding series minute, about 1.5 mm. long, the inner series about 2 mm. distant, membranous at base, filamentose on margin, the filaments 2 mm. long; operculum membranous, horizontally spreading, serrulate at margin; limen cylindric, 7 mm. high, the lower two-thirds adnate to gynophore, the upper third flaring outward; ovary subglobose, glabrous.

Type in the herbarium of the Muséum d'Histoire Naturelle, Paris, collected at Apiahy, São Paulo, Brazil, in 1883, by Puiggari.

Although numerous species have been described in this group of the subgenus *Granadilla* with entire leaves and foliaceous stipules and bracts, none of these descriptions apparently apply to this plant. The material examined at Berlin was distributed as *P. subrotunda*, which appears to be only a small-leaved form of *P. mucronata*. From *P. mucronata*, *P. paulensis* differs in the shape of the bracts, which are borne close to the flower, more slender petioles, leaves of a much thinner texture, and in the arrangement of the corona.

Passiflora dalechampioides Killip, sp. nov.

Plant glabrous throughout; stipules semi-oblong, 1.5 to 3.5 cm. long, 0.7 to 1.5 cm. wide, acute, mucronulate, rounded at base, oblique, attached laterally near base; petioles 2 to 3.5 cm. long, bearing 6 to 9 short-stipitate glands on dorsal side; leaves trisect to within 2 mm. of base (segments lanceolate or elliptic-lanceolate, 3.5 to 10 cm. long, 1 to 3.5 cm. wide, acuminate, mucronulate, glandular-serrulate in sinuses, often overlapping), cordate at base, 3 or 5-nerved, reticulate-veined, subcoriaceous, sublustrous; peduncles 3.5 to 10 cm. long, articulate just below apex; bracts oblong or oblong-lanceolate, 1 to 1.2 cm long, 0.5 to 0.6 cm. wide, acute, mucronulate, thin-membranous, glaucous, borne at point of articulation, flowers about 4.5 cm. wide, "greenish blue," the tube short-campanulate; sepals linear-oblong, about 2 cm long, 0.6 to 0.8 cm. wide, cucullate and short-awned at apex; petals linear, about 1 cm. long, 0 3 cm. wide, corona filaments in 3 series, the outermost filiform, about 7 mm. long, the two inner capillary, 2 to 3 mm. long; operculum membranous, 2 mm high, denticulate; nectar ring a short membrane; limen tubular, adnate to base of gynophore; ovary ovoid; fruit ovoid, 4 cm. long, 2 cm. wide (probably larger), the exocarp coriaceous; seeds obovate-oblong, about 5 mm. long, 3 mm. wide, reticulate.

Type in the U. S. National Herbarium, no. 943534, collected at Coroico, Yungas, Bolivia, in September, 1894, by M. Bang (no. 2441). Duplicates in the herbarium of the New York Botanical Garden and in the Gray Herbarium.

This collection was identified by Masters as *P. trisulca*. The leaves bear a general resemblance to that species, though they are much more deeply lobed, and the petiolar glands are more numerous. The flowers are smaller, the outer corona filaments filiform, not liguliform, and the operculum merely denticulate. The shape of the leaves suggests rather *P. weberbaueri*, a wholly different species of the subgenus *Granadillastrum*.

Passiflora rubrotincta Killip, sp. nov.

Plant glabrous throughout; stem terete, wiry, drying yellowish; stipules subreniform, 1.5 to 2 cm long, 0.5 to 0 8 cm wide, minutely mucronulate at one end, rounded at other, remotely crenulate or subentire, coriaceous; petioles about 2 cm. long, glandless; leaves 4 5 to 8 cm. long and wide, angulately 3-lobed (middle lobe ovate-deltoid, 3 to 4 cm. long, 4 to 5 cm. wide at base, obtusish, the lateral lobes less than half as long), distinctly peltate, truncate at lower margin, 5-nerved, coriaceous, dark green and lustrous above, dull and reddish beneath; peduncles 4 to 7 cm. long, slender, articulate about 2 mm. from apex; bracts cordate-ovate, about 1 cm. long, 0.7 cm. wide, acute, mucronulate, reddish; flowers 4 to 5 cm. wide, the tube campanulate; sepals oblong-lanceolate, about 5 mm. wide at base, coriaceous, dorsally awned just below apex, the awn foliaceous, about 1 cm. long; petals linear-spatulate, slightly shorter and narrower than the sepals; corona filaments filiform, in 3 (or 4?) series, the inner barely 2.5 mm. long; operculum membranous and non-plicate below, filamentose above, the filaments about 3 mm. long; limen tubular, closely surrounding base of gynophore; ovary ovoid.

Type in the herbarium of the New York Botanical Garden, collected in Bolivia, the precise locality not stated, by M. Bang (without number).

The angularly lobed, distinctly peltate leaves at once differentiate this species from relatives of the subgenus *Granadilla.*

Passiflora tenuifila Killip, sp. nov.

Plant glabrous throughout; stem terete or the younger parts subangular; stipules semi-oblong or subreniform, 1 to 4 cm. long, 0.5 to 2 cm. wide, obtuse or acutish, mucronulate at apex, rounded at base, subentire, glaucescent beneath; petioles 2 to 5 cm. long (lower up to 8 cm.), 2 to 5-glandular, the glands up to 2 mm long, thickened at base, scattered or subopposite; leaves 3.5 to 8 cm. along midnerve, 3 to 7 cm along lateral nerves, 5 to 12 cm. between apices of lateral lobes, 3-lobed two-thirds to three-quarters their length (lobes oblong or obovate-oblong, 1 to 3 5 cm wide, rounded or obtuse, mucronulate at base, glandular-serrulate in the acutish sinuses, the middle lobe narrowed at base), cordate, 5-nerved, subpeltate, membranous, glaucescent beneath; peduncles 3 to 8 cm long, slender, articulate less than 2 mm. from apex; bracts cordate-ovate, 1 to 1.5 cm. long, 0.6 to 1 2 cm. wide, abruptly acute and mucronate at apex, glandular-serrulate at base, glaucous, borne at point of articulation, persistent; flowers up to 3.5 cm. wide, the tube patelliform, introrse at base; sepals narrowly oblong, 5 to 7 mm. wide, obtuse, carinate, bright green along the keel, white at margin, the keel terminating in a foliaceous awn 4 to 6 mm. long; petals about two-thirds as long and as broad as sepals, obtuse, white; corona filaments very slender, almost capillary, in 4 series, the outer two 5 to 7 mm. long, radiate, the inner two 1.5 to 2 5 mm. long; operculum membranous, 1 mm. high, slightly plicate at margin, filamentose, the filaments attached dorsally just below margin, 1 to 1 5 mm. long; nectar ring a low fleshy ridge; limen shallowly cupuliform, loosely surrounding base of gynophore; ovary ovoid, glaucescent.

Type in the U S National Herbarium, no. 1,232,864, collected at Marechal Mallet, Paraná, Brazil, about 800 meters altitude, January 2, 1904, by P. Dusén. A duplicate of this collection is in the Gray Herbarium.

BRAZIL: Ijuhy, Rio Grande do Sul, *Lindman* 1363 (U. S. N. M.).

PARAGUAY: Along Upper Paraná River, *Fiebrig* 6230 (U. S. N. M., Gray).

This material was distributed as *P. coerulea* and *P. tucumanensis.* The species is not even closely related to *P. coerulea,* differing greatly in leaf shape and flower structure. Though belonging to the complex group of granadillas with 3-lobed leaves and foliaceous stipules, it is at once distinguished by small flowers with very short, almost capillary corona rays. *Passiflora tucumanensis, P. naviculata,* and *P. giberti* in general appearance closely resemble *P. tenuifila,* but, in addition to larger flowers with coarser corona rays, the first two have glandless petioles, and the third has a distinctly plicate operculum.

Passiflora phaeocaula Killip, sp. nov.

Plant scandent, the tendrils well-developed; stem subquadrangular, slender, dark purple; stipules setaceous, soon deciduous; petioles 5 to 8 mm. long, glandless or obscurely glandular at base of leaf, minutely puberulent; leaves oval, 3.5 to 5 cm. long, 2 to 2.5 cm. wide, rounded and slightly emarginate at apex, rounded at base, entire, penninerved (lateral nerves 5 to 7 to a side), reticulate-veined (nerves and veins elevated and conspicuous on both surfaces), thick-coriaceous, lustrous and glabrous above, dull and minutely puberulent beneath; peduncles solitary in axils, 1-flowered, 4 to 6 mm. long, shorter than the adjacent petiole; bracts soon deciduous; flower tube funnel-shaped, about 8 mm. long, 5 mm. wide at throat, dark-maculate within; sepals narrowly oblong, about 2 cm. long, 0.6 cm. wide, obtuse, ecorniculate; petals similar and subequal to sepals; corona filaments in 2 series, the outer about 1 cm long, subdolabriform, linear below, dilated to width of about 1.5 mm. above middle, attenuate at tip, the inner filiform, about 1.5 mm. long, shallowly bifid; operculum borne in lower third of tube, erect, 4 mm. long, filamentose nearly to base, ovary ovoid, puberulent.

Type in the herbarium of the New York Botanical Garden, collected along the Upper Rio Negro, Brazil, in 1907 or 1908, by Weiss and Schmidt.

Among species of the section *Pseudoastrophea* this is most readily recognized by the small, very thick leaves with a conspicuous much-elevated reticulate venation. The peduncles are shorter than the petioles, in this respect resembling only *P. candida.* In both series the corona filaments are much fewer than in *P candida, P. haematostigma*, and other relatives, and the outer filaments are essentially entire at the margin of the dilated portion.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY

392ND MEETING

The 392nd regular meeting was held April 7, 1927, in the U. S. Department of Agriculture Motion Picture Laboratory, 1363 C Street S W. President J. A HYSLOP presided. There were present 23 members and 15 visitors.

Mr. FLOYD F. SMITH, of Willow Grove, Penn., was elected to membership.

Program: W. H. LARRIMER: *The control campaign against the European corn borer.* (Illustrated by two motion picture films of the Department entitled "The corn borer and what to do about it," and "Corn and the borer," —and also by several lantern slides dealing with the various phases of the corn borer activities, such as copies of the original $10,000,000 authorization and appropriation bills, organization charts for the campaign, portraits of some of the executive personnel) In addition to data in explanation of the film and the slides the speaker gave a brief outline of the events of the past few months concerning the corn-borer clean-up campaign, with not only emphasis on the scope and magnitude of the enterprise, but also with emphasis on its experimental character, as being solely an effort to check the spread of the pest, and with no attempt at absolute extermination of it, the experimental character of the campaign being clearly realized and understood not only by the President, the Director of the Bureau of The Budget, and the Congressional Committee, but also by the International Corn-Borer Committee, some of the members of which were most active in obtaining the ten million dollar appropriation.

A. C. BAKER: *The citrus white fly in California.* The speaker gave a brief account of the campaign against this pest and his visit to that State in this connection. He pointed out that a previous attempt had been made to eradicate the white-fly, which, probably due to a lack of knowledge of its host plants, was unsuccessful. The present campaign resolved itself for this same reason into one of treating the entire infested area, in the hope of reducing the white-fly population to a point where danger of its transfer to the southern citrus region would be minimized, and if possible to a point where eradication might be considered feasible.

Informal remarks were made on request by T. H COLEBROOK TAYLOR, who has been working on cocoanut insects in the Fiji Islands, and who was en route to his old home in England on a vacation. He gave a brief outline of his work and experiences in the South Seas, and discussed with some detail his researches on the life history and control of *Levuana iridescens* Bath-Baker, a serious pest of cocoanuts in Fiji This injury, commonly known as "Browning disease," was first noticed by explorers in 1860, and again was recorded in 1907. By 1923 it had spread to about a hundred of the near-by islands. Considerable time in control work was given to spraying experiments with lead arsenate paste and sea water, but much difficulty was experienced in spraying because of the great height, 90 feet or more, of the cocoanut trees, and because of the corrosive qualities of the sea water on the spraying equipment Search was made in a number of the other countries for parasites, and, at last, in Java, a Tachinid, *Ptychomyia remota* Aldrich, was found. Serious difficulties were encountered in actual transportation by steamer of the parasites because of inadequate facilities, lack of ice, etc., for properly taking care of them. Much of the rearing work, too, was done under highly adverse conditions. He also touched briefly upon explorations made in other places, notably those in New Guinea and the Solomon Islands.

Dr. BÖVING directed attention to two copies of a Danish entomological Magazine, "Entomologiske Meddelelser," vol 15, Nos 5 and 6, 1926, which contained an article entitled "The History of Danish Entomology" by Kai L. Henricksen, stating that it presented a very excellent résumé of the subject and that there was included a number of good portraits of the outstanding leaders of the work in that country, and natives who in other countries have been identified with entomological work

Mr. ROHWER directed attention to an old paper by Fabricius written in 1774 in which the author had recorded a thought quite similar to that expressed recently in an address by Dr. Howard that if we only had closer acquaintance with and more intimate knowledge of insects we could better learn to control them.

J. S. WADE, *Recording Secretary.*

JOURNAL

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CHEMISTRY.—*Diazo sulfonates.*[1] W. L. Hall and H. D. Gibbs, Hygienic Laboratory, U. S. Public Health Service.

In 1868, about a decade after Griess' epoch making discovery of the diazo compounds, Schmitt and Glutz,[2] while studying the reactivity of these compounds towards various reagents, synthesized the first diazo sulfonates. They observed that the addition of moist diazonium chlorides to concentrated solutions of sodium hydrogen sulfite produced clear yellow solutions which did not evolve nitrogen even when heated to boiling. From diazotized ortho- and paraaminophenol, treated in this manner, they isolated beautiful yellow crystalline compounds having the formula $C_6H_4 \cdot OH \cdot N_2SO_3K$. They concluded that the acid sulfite had condensed with the diazo phenols and predicted that the reaction would be characteristic for all diazo compounds.

Strecker and Romer[3] (1871) studied the behavior of diazo-benzene towards potassium hydrogen sulfite and, as predicted by Schmitt and Glutz, obtained a condensation of the acid sulfite with the diazo compound, but they noted that during the reaction sulfur dioxide was evolved. Their recrystallized compound was colorless and reduced certain metallic salts, and an analysis gave the molecular formula $C_6H_7N_2SO_3K$. They proved that the sulfonic group was not directly attached to carbon and attempted to write a structural formula for the compound, but failed to recognize the simple relationship between their experiments and those of Schmitt and Glutz.

Fischer[4] (1875) seems to be the first to explain the mechanism of

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[1] Published by permission of the Surgeon General, U. S. Public Health Service Received Sept. 2, 1927.

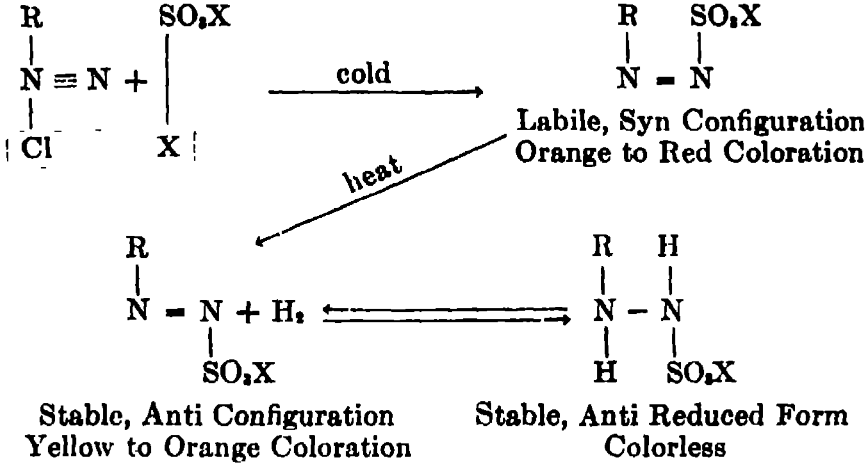
[2] Ber. Deutsch. Chem. Ges. 2: 51. 1869.

[3] Ber. Deutsch. Chem. Ges. 4: 784. 1871.

[4] Ber. Deutsch. Chem. Ges. 8: 589. 1875.

the syntheses. He proved that Schmitt and Glutz's yellow compound and Strecker and Römer's colorless compound were similar in type. In repeating Strecker and Römer's work, Fischer used neutral sulfite and later alkaline sulfite,[5] and obtained a yellow compound whose molecule contained two less hydrogens than found by Strecker and Romer With oxidizing and reducing agents, Fischer was able to convert a yellow compound into a colorless one and *vice versa,* thereby demonstrating a chemical reversibility.[6]

Diagramatically, the synthesis and reversibility of the diazo sulfonates may be represented by the following equations,[7] where R is an aromatic radical and X a metal.


R
N ≡ N +
Cl
SO₃X
X
cold
R SO₃X
N = N
Labile, Syn Configuration
Orange to Red Coloration
heat
R
N = N + H₂
SO₃X
R H
N – N
H SO₃X
Stable, Anti Configuration
Yellow to Orange Coloration
Stable, Anti Reduced Form
Colorless

This property of the diazo sulfonates to undergo reversible oxidation and reduction, and the possibility of measuring their electrode potentials, instigated the syntheses of 10 of these compounds, five of which apparently are new. So far, measurements made of the electrode potentials are not conclusive enough to warrant publication of this phase of the problem.

The part played by the diazo sulfonates in advancing the science of chemistry has been an important one. E. Fischer's[8] researches on the use of the diazo sulfonates in hydrazine synthesis, first discovered by Strecker and Römer,[9] has indeed proved to be a very fruitful piece of work. The use of the diazo sulfonates by Hantzsch, Bamberger, Blomstrand, and others, as evidence for and against the constitution of diazo salts, has been noteworthy. Many substitution products of the simplest benzene diazo sulfonates were synthesized in the search for a stable molecule of the syn configuration. These researches have thrown some light on the stabilization of such a labile molecule.

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[5] Ann Chem 190: 67 1878

[6] Although Strecker and Römer noted that when their compound reduced silver nitrate a yellow solution was produced, and from this solution they isolated a yellow silver salt, they were at loss for an explanation as to what had taken place.

[7] Adopting Hantzsch's theories For a detailed discussion of the stereochemistry of the diazo sulfonates see J. C. CAIN, *The chemistry and technology of the diazo compounds,* Edward Arnold, London, 1920; and LACHMAN, *The spirit of organic chemistry,* p. 216, The Macmillan Co., New York, 1904.

The outstanding characteristic of these compounds in the pure state, synthesized as here described, is their surprising stability. The authors have on hand some compounds that gave a check analysis after the lapse of over a year and a half. Apparently, all diazo sulfonates will keep perfectly when not exposed to moisture and excess light. All the sodium or potassium salts containing a single aromatic ring that have either been studied or described are yellow to orange and give like-colored solutions, the color and solubility depending upon ring structure.

Hydrazine sulfonic acids[10] can be prepared from the diazo sulfonates by reduction with zinc dust and acetic acid. By careful recrystallization, avoiding oxidation,[11] colorless crystalline compounds may be obtained.

Like many organic syntheses, the production of the diazo sulfonates is comparatively simple when one has learned from experience the proper procedure. Experiments have shown that success lies in the proper control of the pH. As Fischer showed the Schmitt and Glutz method to be faulty, so do we find the Fischer and subsequent methods inadequate when applied to certain intermediates. One must always bear in mind that at no time during the condensation should sulfur dioxide be liberated. Should this happen there may be obtained a gummy mass or even a tar, which possibly is a mixture of the oxidized and reduced sulfonates, sulphazides, and what not. Only a slight excess of sulfite should be used in certain cases, otherwise disulfonates of type formula $R \cdot NSO_3NaNHSO_3Na$ may be obtained, where R is an aromatic radical, usually containing nitro or sulfonic acid groups.

Since in practically all diazotizations here considered an excess of acid is necessary and at the same time prevents the formation of diazo amido compounds, one is confronted with the problem of obtaining a reaction between the diazonium solution and sulfite without liberating sulfur dioxide. Investigators in the past evaded this difficulty by either isolating the diazonium compound and using neutral or acid sulfite solution, or by adding the diazonium solution directly to sulfite made excessively alkaline. Later workers showed that if after diazotization the excess acid was neutralized near 0° and this solution added to sodium sulfite good results were obtained, but we found the method did not apply in all cases. The following procedure was finally devised and worked excellently where the others had failed. The diazotized solution was added, simultaneously with an amount of sodium hydroxide sufficient to neutralize the excess acid, to the cooled sodium sulfite solution, the rates of adding the alkali and diazonium solutions being such that the pH of the reaction was kept between empirical values and at no time was sulfur dioxide liberated or alkali concentration high enough to cause decomposition.

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[8] Ber. Deutsch. Chem. Ges. 8: 592, 1005. 1875.

[9] Ber. Deutsch. Chem. Ges. 4: 785. 1871.

[10] E. Fischer. Ber. Deutsch. Chem. Ges. 8: 590. 1875.

[11] H. Reisenegger. Ann. Chem. 221: 315. 1883.

In all cases, except one, a yield of crystals colored from a brownish orange to almost red, was found to be caused by too great an alkalinity during the reaction.

Whatever the procedure, experience has proved that for good yields high concentrations of all solutions are advisable, and even then salting out of the product is necessary for the very soluble compounds.

EXPERIMENTAL DATA[12]

1-Methylbenzene-2-diazosodiumsulfonate

$1\text{-}CH_3 \cdot C_6H_4\text{-}2\text{-}N_2SO_3Na$

To 10.7 grams of commercial ortho toluidine[13] were added 30 cubic centimeters of water and 25 grams of concentrated (36 per cent) hydrochloric acid. Upon cooling, crystals of the hydrochloride separated. Nevertheless at 0° the suspension was easily diazotized with 21 to 24 cubic centimeters of a 36 per cent solution of sodium nitrite. The end-point was determined with starch iodide paper. A beaker containing 52 cubic centimeters of a 25 per cent sodium sulfite solution[14] was surrounded by a salt-ice mixture and the diazotized solution run into the cold sulfite suspension until a spot plate determination showed the reacting solution to have an acidity of about pH 5.6 (deep blue to brom cresol green or just orange red to brom phenol red). Cold 20 per cent sodium hydroxide was next dropped in until the alkalinity increased to about pH 8.2 (yellowish green to thymol blue); more diazotized solution was then added until pH 5.6 was noted, then more alkali until pH 8.2, and so on in alternation until all the diazotized solution was added. At the end the alkalinity of the liquid should be adjusted to about pH 10 (distinctly blue to thymol blue). A total of 6 to 8 cubic centimeters of the 20 per cent alkali is required. With a little experience one can add simultaneously to the sulfite, the alkali and diazotized solution, and still keep within the required pH (5.6 to 8.2) zone. During the reaction beautiful light orange plates separated, which probably were a mixture of the syn compound and crystals of sodium sulfite. The beaker was removed from the ice bath, 10 grams of sodium chloride added, and the whole heated slowly with stirring at 70°. The resulting deep orange red solution was filtered and cooled to 0° with occasional stirring. Clumps of short yellow needles crystallized. These were separated from the mother liquor and purified by three recrystallizations from hot water, in which they were very soluble. The compound was dried at reduced pressure over soda lime-calcium chloride-caustic soda mixture. All subsequent drying of crystals was made in this manner unless otherwise stated.

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[12] The authors are indebted to C. G. Remsburg, Division of Chemistry, Hygienic Laboratory, for the analyses of the following compounds, except the nitrogen determinations which we determined by the combustion method.

[13] Although these quantities are for tenth molal proportions, ten times the amounts, or molal quantities, were found to work equally well.

[14] Sodium sulfite slowly changes to sulfate. It is therefore advisable to make previously a rough analysis. We found it convenient to use an analyzed saturated solution kept in a tightly stoppered bottle.

Analysis:

Calculated for $C_7H_7N_2SO_3Na$: N 12.61, S 14.43

Found: N 12.78, S 14 22

Colorless crystals of the hydrazine sulfonate were prepared by reduction of a hot saturated 25 per cent acetic acid solution of the diazo sulfonate with an excess of zinc dust, heating and stirring on a steam bath until the solution was practically colorless. After filtering and cooling the crystals separated, but no further investigation was made.

1-Methyl-4-sodiumsulfonatebenzene-2-diazosodiumsulfonate

$1\text{-}CH_3\text{-}4\text{-}SO_3Na \cdot C_6H_3\text{-}2\text{-}N_2SO_3Na$

To 18.7 grams (see footnote 13) of commercial 2-aminotoluene-4-sulfonic-acid was added 30 cubic centimeters of water and only 15 grams of concentrated 36 per cent hydrochloric acid. To the suspension, cooled to 0°, 21 to 24 cubic centimeters of a 36 per cent solution of sodium nitrite was added. The diazotized compound was partially insoluble and evidence of its precipitation was noted after one-half of the amount of nitrite had been added. The end-point was determined with starch iodide paper. There was slowly dropped into the yellow diazotized suspension 13 cubic centimeters of a 40 per cent sodium hydroxide solution, forming the sodium salt of the sulfonic acid and neutralizing the excess acid. Although a suspension still persisted, 52 cubic centimeters of a 25 per cent sodium sulfite solution was added, producing a complete solution. At no time was the temperature of the reaction allowed to rise above 10°, and at the end the pH of the solution was about 9 0 (blue to thymol blue). Upon adding 25 grams of sodium chloride, heating to 70°, filtering and cooling, deep yellow, short needles crystallized. These were separated and recrystallized twice from hot water. Great care was exercised in recrystallization since this compound was extremely soluble in hot and cold water. The purified product was dried at 100° and when dry it absorbed moisture very quickly from the atmosphere.

Analysis:
Calculated for $C_7H_6N_2S_2O_6Na_2$: N 8.64, S 19.78
Found: N 8.69, S 19.42

By means of acetic acid and zinc dust reduction, the colorless hydrazine sulfonate was prepared.

1,3-Dimethylbenzene-4-diazosodiumsulfonate

$1,3(CH_3)_2C_6H_3\text{-}4\text{-}N_2SO_3Na$[15]

To 12.1 grams (see footnote 13) of commercial 4-aminometaxylene was added 30 cubic centimeters of water and 25 grams of concentrated 36 per cent hydrochloric acid. Exactly the same procedure and quantities of nitrite, sulfite, and alkali were used as in making 1-methylbenzene-2-diazosodiumsulfonate. In the present case, however, 25 grams of sodium chloride was added and subsequent heating to 70° caused a slight tarring which we were not able to prevent.

The tar was easily removed in the filtration and gave no further trouble. On cooling the hot solution to 0° bundle-like short orange yellow needles separated. They were filtered, recrystallized from hot water, and dried.

Analysis:
Calculated for $C_8H_9N_2SO_3Na$: N 11.86, S 13.58
Found: N 12 15, S 13 29

By means of acetic acid and zinc dust the compound was reduced to the colorless hydrazine sulfonate. Upon drying, the crystals became slightly pink.

1-Hydroxy-2,6-dichlorobenzene-4-diazosodiumsulfonate

$1\text{-}HO\text{-}2,6\text{-}Cl_2 \cdot C_6H_2\text{-}4\text{-}N_2SO_3Na$

Schmitt and Glutz[16] (1868) in a simple quantitative manner synthesized a dichlorophenoldiazosulfonate. They must, however, have used a 4,6-dichloro-2-aminophenol as their starting material.

We diazotized commercial 2,6-dichloroparaaminophenolsulfate, in the usual manner. The diazotized compound precipitated[17] and the suspension

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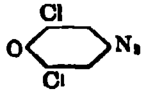
[15] The synthesis and reduction of this compound showed it to be the most unstable of the series

[16] Ber. Deutsch. Chem Ges. 2: 52. 1869.

[17] Paraaminophenol, when diazotized and treated with a sodium hypochlorite solution made according to the method of Raschig (Ber Deutsch. Chem. Ges 40: 4586. 1907), substituted two chlorine atoms in the 2,6-position of the ring and gave the same type of precipitate. Indications are that the precipitate was an anhydride having the graphic formula.



Evidence in favor of such a structure is as follows:

Certain diazotized compounds form similar anhydrides, as, for example, diazotized sulfanilic acid. A corresponding precipitate was obtained when 2,6-dibromoparaaminophenol was diazotized whereas its methyl ester was soluble. In the last case the substituted methyl group prevented formation of the anhydride.

was added to a slight excess of the molecular requirement of alkaline sodium sulfite. The sulfite, in this case, was not completely in solution and contained enough 20 per cent sodium hydroxide to neutralize the excess acid used in diazotization. After standing for an hour, with occasional stirring, the whole was heated to 70°, filtered and cooled. The crystallized yellow plates were separated, recrystallized three times from hot water, and dried. The dry compound quickly absorbed moisture from the atmosphere.

Analysis:

Calculated for $C_6H_3N_2Cl_2SO_4Na$: N 9.56, S 10.94, Cl 24.20
Found: N 9.55, S 10.72, Cl 24.14

Upon reduction with zinc dust and acetic acid, the hydrazine sulfonate[18] was prepared in colorless crystals.

1-Hydroxy-2,6-dibromobenzene-4-diazosodiumsulfonate

$1\text{-}HO\text{-}2,6\text{-}Br_2\text{-}C_6H_2\text{-}4\text{-}N_2SO_3Na$

Böhmer (1881)[19] first made this compound by brominating paradiazophenol with bromine water. He separated the precipitated diazotized product, treated it with sodium hydrogen sulfite and heated His diazosulfonate contained 2 molecules of water of crystallization. Hantzsch and Davidson (1896)[20] prepared the potassium salt of this diazosulfonate, using potassium sulfite as a sulfonating agent. In repeating Böhmer's work, we found that his method of bromination with bromine water required too large a volume.[21] Therefore we first synthesized 2,6-dibromo-4-aminophenol by the bromination, in an acetic acid solution, of paranitrophenol

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The precipitate was separated and dissolved in 36 per cent hydrochloric acid at 20° A residue was filtered and the filtrate reduced at 0° with a solution of stannous chloride in 36 per cent hydrochloric acid. The hydrazine hydrochloride, $1\text{-}HO\text{-}2,6\text{-}Cl_2,C_6H_2\text{-}4\text{-}NHNH_2HCl$, so obtained was filtered, dissolved in water, and twice precipitated from its solutions by adding one-half its volume of 36 per cent hydrochloric acid. After drying over caustic soda—soda lime mixture it gave only a poor analysis, and as it was found to be rather unstable even when isolated and dried, no further study was made

A preliminary report of this hydrazine was presented at the Washington, D. C, meeting of the American Association for the Advancement of Science, Dec 29, 1924

[18] Although we were able to obtain the hydrazine hydrochloride by stannous chloride reduction, the Fischer hydrazine sulfonate method gave no results.

[19] Journ. Prakt Chem 24: 453, 465 1881.

[20] Ber. Deutsch. Chem. Ges. 29: 1532 1896

[21] We used a modified procedure by which a tenth of a mol of diazotized paraaminophenol was easily brominated in a small volume The brominating solution was prepared as follows. Bromine, 35 grams, was dissolved in a saturated solution of 40 grams of potassium bromide at 20°. The solution was then diluted to a volume of 400 cubic centimeters. When the concentrated bromine solution was added, with stirring, to the diazotized phenol in the presence of much crushed ice, the anhydride of 2,6-dibromo-4-diazophenol was precipitated The precipitate was separated, dissolved in 36 per cent hydrochloric acid, reduced to the hydrazine, etc (see footnote 17). The hydrazine hydrochloride, $1\text{-}HO\text{-}2,6\text{-}Br_2C_6H_2\text{-}4\text{-}NHNH_2HCl$, so obtained, although apparently more stable than the dichloro compound, decomposes slowly in solution and likewise when dry.

Analysis.

Calculated for $C_6H_7ON_2Br_2Cl$: N 8.80
Found· N 9.00

(Möhlau and Uhlman 1895).[22] The 2,6-dibromonitrophenol was reduced at 70° with tin and concentrated hydrochloric acid and the tin precipitated with hydrogen sulfide. The 2,6-dibromo-4-aminophenolhydrochloride when diazotized precipitated, and the suspension was added directly to a 10 per cent excess over the calculated quantity of alkaline sodium sulfite suspension, heated, cooled and crystallized. The purified diazo sulfonate, when dried at reduced pressure, did not contain two molecules of water of crystallization, as did Böhmer's compound.

Analysis:

Calculated for $C_6H_3N_2Br_2SO_4Na$:	N 7.33,	S 8.39,	Br 41.85
Found:	N 7.36,	S 7.71,	Br 42.15

Zinc dust and acetic acid reduced the compound to the colorless hydrazine sulfonate.[23] The isolated crystals were not analyzed.

1-Methoxy-2,6-dibromobenzene-4-diazosodiumsulfonate

$1\text{-}CH_3O\text{-}2,6\text{-}Br_2 \cdot C_6H_2\text{-}4\text{-}N_2SO_3Na$

Hantzsch and Pohl[24] (1902), after the method of Stadel[25] (1882) and Korner[26] (1874), synthesized 2,6-dibrom-4-anisidine by the use of methyl iodide in the mythelation of the silver salt of 2,6-dibromo-4-nitrophenol and reducing the methylated compound. The resulting dibromoanisidine was specially diazotized and from the isolated diazonium nitrate, both the syn and antidiazotates were made. They found the two isomeric diazotates to have approximately the same stability. Apparently they did not extend their researches into the corresponding diazosulfonates. Since our interest lay in the antidiazosulfonate we synthesized it by methylating 2,6-dibromo-4-nitrosodium-phenolate by means of dimethylsulfate in several different ways. The methylation of this compound is the subject of an interesting study which we hope to describe in a future article.

The compound was recrystallized at 60° from ethyl alcohol containing 10 per cent, by volume, of acetone and one per cent of sodium hydroxide. A portion of this product when further crystallized from ethyl alcohol gave a melting point of 122.7° against 122.6° (uncorrected) in the literature.[24] Another portion recrystallized from chloroform gave a melting point of 123.7° (uncorrected). The compound sublimed very slowly at 95° and the sublimed product likewise gave a melting point of 123.7° (uncorrected).

Reduction to the 2,6-dibromoanisidine was accomplished by treating 104 grams of the dibromonitroanisol with 275 cubic centimeters of 36 per cent hydrochloric acid and 80 grams of granulated tin. The tin was added in small portions to the continuously stirred suspension. If the temperature was kept between 75° to 85°, the reduction proceeded satisfactorily

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Böhmer (Journ. Prakt Chem. 24: 472. 1881) tried to synthesize this hydrazine by reducing the isolated diazonium compound with zinc dust and acetic acid. He proved its presence in a qualitative way but because of instability never isolated it.

A preliminary report on this hydrazine was made at the Washington, D. C., meeting of the American Association for the Advancement of Science, Dec. 29, 1924.

[22] Ann. Chem. 289: 94. 1896.

[23] Attempts to prepare the hydrazine hydrochloride by the Fischer method were unsuccessful.

[24] Ber. Deutsch. Chem. Ges. 35: 2969. 1902.

[25] Ann. Chem. 217: 70. 1883.

[26] Gazz. chimi ital 4: 390. 1874.

and completion was noted after 3 to 4 hours. At the end there was a brown solution having approximately a volume of 600 cubic centimeters at 102°. The tin double salt crystallized upon cooling, was separated, dissolved in hot water, and the tin was precipitated by leading hydrogen sulfide into the hot solution. The hydrochloride of the dibromoanisidine crystallized from the filtered, hot, tin-free solution. A portion was recrystallized from 20 per cent hydrochloric acid, dried[27] and analyzed.

Analysis:

Calculated for $C_7H_8ONBr_2Cl$: N 4.41
Found: N 4.42

Unlike Hantzsch and Pohl we diazotized the dibromoanisidine in the usual manner except that a decided excess of hydrochloric acid was necessary.[28] For 32 grams of 2,6-dibromo-4-anisidine hydrochloride there were required 200 cubic centimeters of water and 25 grams of 36 per cent hydrochloric acid. This thick suspension was diazotized at 0° to 5° by very slowly dropping in 24 to 26 cubic centimeters of a 36 per cent solution of sodium nitrite. The end-point in this case could not be determined since an excess of nitrite was needed to take care of small lumps of the undiazotized material which seem to react very slowly toward the end. A slight precipitate persisted which was possibly a trace of the anhydride of the unmethylated compound and a small amount of the diazoamino compound. This precipitate was removed by filtration. The excess acid, in the clear diazotized solution,[29] was neutralized by slowly dropping in, with stirring, 60 to 65 cubic centimeters of 10 per cent sodium hydroxide solution. A yellow precipitate was formed. The pH of the suspension had to be adjusted between 5.6 and 5.8 (orange red to brom phenol red) for a successful sulfonation, then 52 cubic centimeters of a 25 per cent solution of sodium sulfite was slowly run in. The contents of the beaker set almost solid, but after a slow heating to 90° a dark orange red solution containing a slight precipitate was produced. The solution was filtered and cooled, whereupon beautiful yellow plates were obtained. The crystals were separated, recrystallized from hot water and dried.

Analysis:

Calculated for $C_7H_6N_2Br_2SO_4Na$: N 7.08, S 8.10, Br 40.37
Found: N 7.06, S 7.50, Br 40.11

By reduction with zinc dust and acetic acid the corresponding colorless hydrazine sulfonate was prepared. The isolated crystals were not analyzed.

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[27] If the compound was dried at 100° it partly sublimed.

[28] In several instances where the acid was not in sufficient excess a yellow insoluble precipitate was formed. Analysis of this precipitate, after recrystallizing from benzene, indicated the formation of the diazoamino compound having a melting point of 187.7°, uncorrected.

Analysis.

Calculated for $C_{14}H_{11}O_2N_3Br_4$: Br 55.81, N 7.34
Found: Br 56.37, N 7.74

[29] When this solution was treated with stannous chloride dissolved in 36 per cent hydrochloric acid, colorless crystals of the hydrazine hydrochloride precipitated. These were filtered, and an attempt to purify them was unsuccessful because all solvents tried caused a decomposition with an evolution of nitrogen. The isolated crystals, when dried over caustic soda, were found to be stable.

1-Hydroxybenzene-4-diazosodiumsulfonate

$1\text{-}HO\cdot C_6H_4\text{-}4\text{-}N_2SO_3Na$

The potassium salt of this compound was first made and described by Schmitt and Glutz[20] (1868) as containing water of crystallization. As previously mentioned they used potassium hydrogen sulfite as the sulfonating agent. Fischer[21] (1877) made the compound by the use of alkaline sulfite. Reisenegger[22] (1883) showed that Schmitt and Glutz's compound did not contain a molecule of water of crystallization. We made the sodium salt of this diazo sulfonate by adding a diazotised solution of paraaminophenol to a 10 per cent excess over the calculated quantity of alkaline sodium sulfite. After heating to 70°, filtering and cooling, there was produced a mass of canary yellow crystals. These were separated, recrystallized from hot water three times and dried.

Analysis:

Calculated for $C_6H_5N_2SO_4Na$:	N 12.50,	S 14.31,	Na 10.26
Found:	N 12.43,	S 14.40,	Na 10.43

Like Reisenegger[23] (1883) we obtained the colorless hydrazine sulfonate upon reduction with zinc dust and acetic acid. The addition of ethyl alcohol to a cold saturated solution of this compound caused it to crystallize. No further study was made.

1-Ethoxybenzene-4-diazosodiumsulfonate

$1\text{-}C_2H_5O\cdot C_6H_4\text{-}4\text{-}N_2SO_3Na$

Altschul[24] (1892) first synthesized this compound by treating diazotised paraaminophenetol with alkaline sodium sulfite. We likewise prepared it with alkaline sodium sulfite.

Analysis:

Calculated for $C_8H_9N_2SO_4Na$:	N 11.11,	S 12.72
Found:	N 11.12,	S 12.51

By a method similar to that of Altschul[25] (1892), with zinc dust and acetic acid, we easily reduced the compound to the colorless hydrazine sulfonate. The isolated crystals were not analyzed.

1-Dimethylaminobenzene-4-diazosodiumsulfonate

$1\text{-}(CH_3)_2N\cdot C_6H_4\text{-}4\text{-}N_2SO_3Na$

Stollé[26] (1912) made this compound by isolating the diazonium chloride of diazotized paraaminodimethylaniline, dissolving it in water, and adding a solution of sodium bisulfite. Our method of preparation was perhaps a little simpler inasmuch as the diazotized compound does not have to be isolated. To 17.5 grams of paraaminodimethylaniline hydrochloride dissolved in 300 cubic centimeters of water, was added 15 grams of 36 per cent hydrochloric acid. The solution was diazotized at 0° by slowly adding about 42 cubic centimeters of an 18 per cent sodium nitrite solution. The end-point was determined by starch iodide paper. The diazotized solution was slowly run into an alkaline sodium sulfite mixture (52 cubic centimeters of 25 per cent sodium sulfite plus 28 cubic centimeters of a 10 per cent solution of sodium hydroxide). The pH of the resulting brown suspension was about 9.0 (blue to thymol blue). Heating to 90°, filtering, and the addition of 70 grams of salt yielded brown needles. These were recrystallized and purified by boiling with decolorizing carbon. The pure, deep brownish orange crystals were dried and analyzed.

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[20] Ber. Deutsch. Chem. Ges. 2: 51. 1869.

[21] Ann. Chem. 190: 73. 1877.

[22] Ann. Chem. 221: 316. 1883.

[23] Ann. Chem. 221: 317. 1883.

[24] Ber. Deutsch. Chem. Ges. 25: 1843. 1892.

[25] Ber. Deutsch. Chem. Ges. 25: 1844. 1892.

[26] Ber. Deutsch Chem. Ges. 45: 2681, 2682. 1912.

Analysis:

Calculated for $C_8H_{10}N_3SO_3Na$: N 16.73, S 12.77
Found: N 16.41, S 12.44

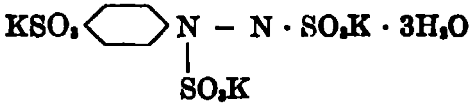
We found this diazo sulfonate to be the least stable in solution. Even in the dark, a hundredth molecular solution decomposed with the separation of a precipitate.

According to Stollé[37] (1912) zinc dust and acetic acid reduce the diazosulfonate to paraaminodimethylaniline.

1-Sodiumsulfonatebenzene-4-diazosodiumsulfonate

1-$NaSO_3 \cdot C_6H_4$-4-N_2SO_3Na

Strecker and Römer[38] (1871) tried to synthesize this diazosulfonate but did not isolate the compound. Fischer[39] (1877) isolated a light yellow compound, apparently a mixture of oxidized and reduced forms. Pechman[40] (1895) prepared the potassium salt, precipitating it with alcohol. He pointed out that in the presence of an excess of sulfite the diazodisulfonate



could be obtained. We confirmed this in a qualitative way. Hantzsch and Schmiedel[41] (1897) also prepared the potassium salt of the diazomonosulfonate but found it to contain a molecule of water of crystallization. We synthesized the sodium salt of this diazosulfonate as follows.

To 96 grams of sulfanilic acid, 125 grams of 36 per cent hydrochloric acid and 200 cubic centimeters of water were added. This was diazotized at 5° with about 115 cubic centimeters of a 36 per cent sodium nitrite solution. The diazotized compound precipitated as the anhydride, colorless needles. Into the cooled suspension 70 cubic centimeters of 40 per cent sodium hydroxide solution was dropped until the pH was 9.8 (blue to thymol blue). The approach to the end-point was noted by a yellow appearance of the diazotized compound. Sodium sulfite, 260 cubic centimeters of a 25 per cent solution, was slowly added and a deep orange solution obtained. Then

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[37] Ber. Deutsch. Chem. Ges. 45: 2680. 1912.

[38] Ber. Deutsch. Chem. Ges. 4: 784. 1871.

[39] Ann. Chem. 190: 76. 1877; Ber. Deutsch. Chem. Ges. 8: 593. 1875.

[40] Ber. Deutsch. Chem. Ges. 28: 863. 1895.

[41] Ber. Deutsch. Chem. Ges. 30: 79. 1897.

100 grams of salt was added and the solution heated to 90°, whereupon a partial separation of the diazo sulfonate took place. Cooling to 5° yielded yellow needles, which were separated and purified by precipitation from a water solution with an equal volume of methyl alcohol. The compound was dried at 100° and then analyzed.

Analysis:
Calculated for $C_6H_4N_2S_2O_6Na_2$: N 9.03, S 20.67
Found: N 9.02, S 20.02

Like Pechman[42] (1895), we obtained the colorless hydrazine sulfonate by reduction with zinc dust and acetic acid. The isolated crystals were purified by methyl alcohol precipitation, and a final washing with absolute methyl alcohol. They were dried at 60°.

Analysis:
Calculated for $C_6H_6N_2S_2O_6Na_2$: N 8.97
Found: N 8.90

SUMMARY

A brief review of the historical development and uses of the diazo sulfonates is given.

In pursuit of certain definite diazo sulfonates 10 were prepared and apparently the following five are new:

1-Methylbenzene-2-diazosodiumsulfonate
1-Methyl-4-sodiumsulfonatebenzene-2-diazosodiumsulfonate
1,3-Dimethylbenzene-4-diazosodiumsulfonate
1-Hydroxy-2,6-dichlorobenzene-4-diazosodiumsulfonate
1-Methoxy-2,6-dibromobenzenediazosodiumsulfonate

Three new hydrazines were prepared:

1-Hydroxy-2,6-dichlorobenzene-4-hydrazinehydrochloride
1-Hydroxy-2,6-dibromobenzene-4-hydrazinehydrochloride
1-Methoxy-2,6-dibromobenzene-4-hydrazinehydrochloride

A new diazoamino compound was prepared:

1-Methoxy-2,6-dibromobenzene-4-diazoamino-4′-methoxy-3′,5′-dibromobenzene

MINERALOGY.—"*Blythite*" *and the manganese garnet from Amelia, Virginia.*[1] EARL V. SHANNON, U. S. National Museum.

In analyzing spessartite or spessartite-bearing garnets during the past several years the writer has at times found difficulty in obtaining an exact agreement of the results of analyses with the general garnet formula, $3RO \cdot R_2O_3 \cdot 3SiO_2$. When the manganese in many garnets high in content of this element is all calculated as manganous oxide the bivalent bases are a little too high and the trivalent oxides correspondingly low. This fact led some time ago to the supposition that manganese in garnets might, like iron, exist in two states of oxidation, bivalent and trivalent, and that there might be small amounts of an unnamed garnet molecule in which the trivalent alumina is replaced by manganic manganese. Although practically convinced that such a molecule exists, the writer has felt disinclined to put foward such a conclusion without experimental proof, and has held the matter in abeyance pending the working out of a suitable method for the determination of manganic manganese in a silicate as insoluble as garnet. The problem was discussed orally with Drs. Clarence S. Ross, Waldemar T. Schaller, Henry S. Washington and Edgar T. Wherry. The present writer was consequently much interested when his attention was directed by Drs. Ross and Schaller to the recent article on garnets by Fermor[3] in which he recognizes and names the following new molecules:

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[42] Ber. Deutsch. Chem. Ges. 28: 868. 1895.

[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received September 7, 1927.

$3FeO \cdot Fe_2O_3 \cdot 3SiO_2$ = Skiagite
$3MnO \cdot Fe_2O_3\ 3SiO_2$ = Calderite
$3MnO\ Mn_2O_3\ 3SiO_2$ = Blythite

Fermor found "blythite," named for the analyst, T. R. Blyth, formerly assistant curator of the Geological Survey of India, in only one of the Indian garnets analyzed. The material is orange-red to orange, and is from the Gondite series, whose rocks are composed largely of manganese garnet and quartz. The oxidation and decomposition of the garnet result in the formation of workable manganese ores, and the garnet rock is thrown by the thousands of tons on the dumps of the manganese mines.[4] The locality of the analyzed material was Chargaon, Nagpur. The analysis follows:

MANGANESE GARNET FROM NAGPUR, INDIA

(T. R Blyth, analyst)

	Per cent
SiO_2	34.71
Al_2O_3	8.05
Fe_2O_3	8.38
MnO	38.83
MgO	5.40
CaO	4.97
BaO	trace
	100.34

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[3] L. LEIGH FERMOR, *On the composition of some Indian garnets.* Records Geol. Surv. India 49: pt. 2: 191–207. 1926.

[4] L. LEIGH FERMOR. Mem. Geol. Surv. India 37: 167–168. 1909.

This analysis is interpreted by Fermor in terms of mineral molecules as follows:

		Per cent
Pyrope	$3MgO \cdot Al_2O_3 \cdot 3SiO_2$	18 78
Almandite	$3FeO \cdot Al_2O_3 \cdot 3SiO_2$	none
Spessartite	$3MnO \cdot Al_2O_3 \cdot 3SiO_2$	17 68
Grossularite	$3CaO \cdot Al_2O_3 \cdot 3SiO_2$	none
Andradite	$3CaO \cdot Fe_2O_3 \cdot 3SiO_2$	16 01
Calderite	$3MnO \cdot Fe_2O_3 \cdot 3SiO_2$	12 81
Blythite	$3MnO \cdot Mn_2O_3 \cdot 3SiO_2$	34 72
		100 00

Since the material is not near the pure end-member, it is called "magnesia-blythite" by Fermor. The specific gravity is given as 4.15 to 4.20. Unfortunately no indices of refraction are given for any of the garnets described in the paper.

While examining the analyses of garnet in the literature the writer noted that the manganese garnet from Amelia, Virginia, according to the analysis quoted by Dana[4] from Bradbury[5] (through Fontaine[6]), showed very low alumina and high manganese content. It was accordingly decided to subject this garnet to a reexamination, to see what information it might yield concerning the possible existence and characteristics of such a molecule as "blythite."

Bradbury's analysis indicates the Amelia garnet to contain only 12.63 per cent of alumina whereas pure spessartite requires 20.6 per cent to conform with the formula. According to Fontaine's description the garnet was found on the walls of a large cavity discovered in pit No. 2 of the Rutherford mica mine. It is in angular masses loosely deposited in the interstices between broad, platy crystals of the clevelandite variety of albite, the garnet being younger than the albite and associated with still younger helvite. The material is stated to be pale pink to flesh-red or, in some fragments, brownish-purple. The fusibility is 3; hardness 6.5; specific gravity 4.20. The analysis and ratios, all manganese being stated as MnO, are as follows:

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[4] E. S. DANA, *System of mineralogy*, 6th ed., spessartite anal. 1, p. 442. 1895.

[5] C. M. BRADBURY. Chem. News 50: 120. 1884.

[6] W. M FONTAINE, *Notes on the occurrence of certain minerals in Amelia County, Va.* Am. Journ. Sci. 3d. ser. 25: 335. 1883.

ANALYSIS AND RATIOS OF SPESSARTITE

(C. M. Bradbury, analyst)

	Per cent	*Ratios*		
SiO_2	36 34	603	.603	121 × 5
Al_2O_3	12 63	124	124.	.124 × 1
Fe_2O_3	——	——		
FeO	4 57	064		
MnO	44 20	623	726	121 × 6
MgO	47	012		
CaO	1 40	027		
	99 70			

This analysis gives rather exactly the formula $6MnO \cdot Al_2O_3 \cdot 5SiO_2$, which certainly cannot be the correct formula for a garnet. Either the mineral is new, the manganese is largely in the manganic form, or there is a serious error in the analytical work. The material was apparently pure, however, and the analytical work appears superficially to be of high grade. If, in the interpretation of the analysis, enough manganese be calculated as Mn_2O_3 to make the ratio for R_2O_3 one-third the ratio for SiO_2, the following results are obtained:

	Per cent	*Ratios*		
SiO_2	36 34.	603	603	201 × 3 (1 00 × 3)
Al_2O_3	12 63	.124	.201	201 × 1 (1 00 × 3)
Mn_2O_3	12 16	077		
FeO	4 57	064		
MnO	33 27.	469	572	191 × 3 (95 × 3)
MgO	47	012		
CaO	1 49	027		
	100 93			

The recalculated figures agree better with the garnet formula, and the mineral molecules, calculated from the bivalent bases, are:

Name	*Formula*	*Mol. weight*	*Ratio*	*Per cent*
"Blythite"	$3MnO \cdot Mn_2O_3 \cdot 3SiO_2$	551 55	077	42 47
Spessartite	$3MnO \cdot Al_2O_3 \cdot 3SiO_2$	495 89	079	39 17
Almandite	$3 FeO \cdot Al_2O_3\ 3SiO_2$	498 65	021	10 40
Grossularite	$3 CaO \cdot Al_2O_3 \cdot 3SiO_2$	451.37	.004	1 81
Pyrope	$3MgO \cdot Al_2O_3 \cdot 3SiO_2$	404 06	009	3 64
				97.56

Recalculating to 100 per cent and prorating the specific gravity, we have:

	Per cent	*Proportional specific gravity*
"Blythite"	43 53	4353y
Spessartite	40 15	1 6783
Almandite	10 73	4560
Grossulaite	1 86	0657
Pyrope	3 73	1309
	100 00	2.3309 + 4353y

The values for index of refraction and specific gravity of the end-members of the garnet group used in the foregoing and the following interpretations are those of Ford,[7] who derived the following constants for the garnet molecules:

	Index (n)	*Specific gravity*
Spessartite	1.800	4.180
Almandite	1.830	4.250
Grossularite	1.735	3.530
Pyrope	1.705	3.510
Andradite	1.895	3.750

Assuming then that the analysis and the determination of the specific gravity for the Amelia garnet are correct, and that the interpretation given correctly represents the garnet, the specific gravity of the pure "blythite" may be calculated from the data given above by the following simple equation in which y is the specific gravity of "blythite:"

$$\begin{aligned} 4353y + 2.3309 &= 4.2000 \\ 4353y &= 1.8691 \\ y &= 4.294 \end{aligned}$$

The specific gravity thus derived for the pure "blythite," 4.294, would make it the heaviest of the common garnets.

If the index of refraction of an analyzed garnet is known, the index of an unknown end-member may be calculated by the same method as for the specific gravity. The analysis and determinations of the physical constants, however, must be highly accurate for the values thus obtained to be of value.

In order to check the published analysis of the Amelia mineral and to secure an analysis of material which could be examined optically, a lot from the U. S. National Museum collections was selected for study. This lot (Cat. No. 47,705), received in March, 1888, as a gift from Dr. George F. Kunz, consisted of five pieces of practically pure garnet having an aggregate weight of over half a pound (265 grams), the largest piece measuring 6 by 4 by 2 centimeters and weighing about 95 grams. The masses are hackly and preserve bladed molds of some platy mineral, probably clevelandite, which has been leached out. The natural unbroken surfaces of the mineral are partly coated with an olive-green clayey substance and show delicate parallel tracings intersecting at the angles of the faces of the rhombic dodecahedron. No other substances are attached to the garnet and it is ideally pure and free from inclusions. The specimens range in color from light to deep reddish amber, are transparent, and have a greasy to resinous luster and conchoidal fracture. In parts the material approaches gem quality. The specific gravity is 4.153, high enough to be noticeable in handling. When crushed, screened, and examined under the polarizing microscope, the sample was found very pure, homogeneous, colorless, and completely isotropic with an index of refraction of 1.794 ± 0.002. The powder screened through 200-mesh is almost white.

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[7] W. E. Ford, *A study of the relations existing between the chemical, optical, and other physical properties of the members of the garnet group.* Am. Journ Sci 4th ser 40: 33–49. 1915.

Upon analysis the following results were obtained, all manganese being stated as MnO:

NEW ANALYSIS OF GARNET FROM AMELIA, VA.

(Earl V Shannon, analyst)

	Per cent	Ratios		
SiO_2	35 76	593	593	198 × 3
TiO_2	trace	—	—	
Al_2O_3	17 38	170	176	.176 × 1
Fe_2O_3	92	006		
FeO	4 90	068	638	213 × 3
CaO	1 66	030		
MgO	22.	006		
MnO	37 98	535		
H_2O	.58			
	99 40			

The ratios are not in exact agreement with the garnet formula. By adding .022 to the ratio for R_2O_3 and subtracting the equivalent .044 from the ratio for R″O the results agree exactly. The recalculated analysis and ratios are then:

	Per cent	Ratios		
SiO_2	35 76	593	.593	.198 × 3
TiO_2	trace			
Al_2O_3	17 38	.170	198	198 × 1
Fe_2O_3	92	006		
Mn_2O_3	3 47	022		
FeO	4 90	068	.595	.198 × 3
CaO	1 66	030		
MgO	.22	.006		
MnO	34 86	.491		
H_2O	58			
	99 75			

Calculated as mineral molecules the revised analysis gives:

	Mol. wt.	*Ratio*	*Per cent*	*Proportional index*	*Proportional specific gravity*
Spessartite	495 89	142	70.41	1 2674	2 9431
"Plythite"	551 55	022	12 13	.1213*n*	.1213*x*
Almandite	498 65	.023	11 47	.2099	.4875
Andradite	508 79	006	3 05	0578	.1144
Grossularite	451 37	004	1 81	.0314	.0639
Pyrope	404 06	002	.81	.0138	.0284
		.199	99 68	1 5803 +.1213*n*	3 6673 +.1213*x*

For the specific gravity, x:

$$\begin{aligned} 1213x + 3\ 667 &= 4\ 153 \\ .1213x &= .486 \\ x &= 4\ 01 \end{aligned}$$

By the same method, for the index n:

$$\begin{aligned} .1213n + 1.5803 &= 1.797 \\ .1213n &= .2137 \\ n &= 1\ 761 \end{aligned}$$

The values just found for specific gravity and index must, however, be considered as only of academic interest and not conclusive, owing to the small proportion of the "blythite" constituent.

There is one other analysis of the Amelia garnet available, that published by Clarke.[8] The mineral is described as brilliant brownish-red masses of considerable size, and although some of the material is dark, the specimen analyzed was very light in color. Like the material in the National Museum, it was received from Dr. George F. Kunz, and was doubtless from the same original lot. The analysis gave the following results and ratios:

ANALYSIS OF GARNET FROM AMELIA, VA.

(F. W. Clarke, analyst)

	Per cent	*Ratios*		
SiO_2	35 35	586	586	195 × 3
Al_2O_3	20 41	.210	227	227 × 1
Fe_2O_3	2 75	017		
FeO	1 75	024	.587	.196 × 3
MnO	38 70	546		
CaO	94	.017		
MgO	none			
Ign.	.27			
	100.17			

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[8] F. W. Clark, *Spessartite from Amelia County, Va.* U. S. Geol. Surv. Bull. 60: 129. 1890.

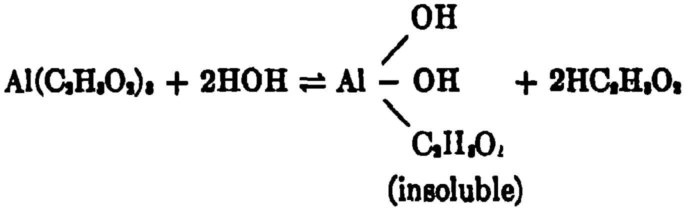
In this case the trivalent bases—alumina and ferric iron—are decidedly higher in percentage than the garnet formula requires, although the silica and bivalent bases are in good agreement with each other. Ford used Clarke's analysis but saw fit to disregard that of Bradbury. The index of refraction and specific gravity accepted by Ford were determined by him for a sample furnished by Dr. Kunz, not for Clarke's analyzed material. The values are 1.8008 and 4.255 respectively.

It becomes pertinent now, after a perusal of the three foregoing analyses, to inquire into the reason for the difference between the results obtained by Bradbury and those of the two subsequent analyses. Either there are garnets from the same locality of distinctly different composition or Bradbury's analysis is in error in the amounts of alumina and manganese oxide determined. Opposed to the first possibility are the facts that all of the specimens are alike in external characters and associations, all came from the same place at about the same time, and probably all from the same pocket. Fontaine gives the specific gravity as 4.20; Ford measured 4.255, and the material analyzed by the writer, as the mean of three determinations, supplied the value 4.153, indicating only moderate variation in composition. Two other specimens with the same catalogue number as the writer's analyzed sample and from the same lot show the garnet in the interstices of beautiful, platy albite masses. Although of various shades of color, this garnet is all identical in index of refraction with the analyzed material. It appears then, highly improbable that there is more than one garnet in the various analyzed lots under consideration.

The second possibility, analytical error, must be considered. Improbable as it may at first appear, it is very easy indeed to confuse aluminum and manganese in analyzing spessartite. It is almost universal practice to separate these constituents, when the manganese is high in amount, by making the first precipitation by the basic acetate method. This consists of adding an excess of an alkali acetate to the cold neutral solution of the chlorides. No precipitation occurs but the following reaction is believed to take place in the cold solution.

$$AlCl_3 + 3NaC_2H_3O_2 = 3NaCl + \underset{\text{(soluble)}}{Al(C_2H_3O_2)_3}$$

On boiling a very voluminous precipitate of basic aluminium acetate separates out thus:



$$Al(C_2H_3O_2)_3 + 2HOH \rightleftharpoons Al\begin{matrix} OH \\ OH \\ C_2H_3O_2 \end{matrix} + 2HC_2H_3O_2$$

(insoluble)

This second reaction is reversible, and if the solution is allowed to cool the precipitate of basic aluminium acetate redissolves. It is therefore necessary to exercise the utmost care to filter the precipitate at boiling and to recover alumina from the filtrate. Otherwise alumina which passed through the filter may be thrown out as an unsuspected impurity in the manganese sulphide of the succeeding separation and may be weighed with the manganese pyrophosphate. The analysis may still foot-up fairly well and the error may pass unnoticed. As a demonstration of this the writer ran an analysis of a massive spessartite from Connecticut which is to be described in another paper. With the exercise of every precaution to avoid loss of aluminum this analysis gave 20.48 per cent of Al_2O_3. Carelessly rerun, with the basic acetate precipitate allowed to cool and without special recovery of alumina from the filtrate, this same mineral gave only 9.64 per cent of Al_2O_3. It seems quite likely that this explanation accounts for Bradbury's results, and one is inclined to wonder whether the single analysis of the "magnesia blythite" from India, with its high percentage of manganese, may not have a similar explanation. An error of one per cent in the determination of alumina in the analysis would cause an error of 5.41 per cent in the "blythite" in the calculation of the mineral molecules—a large factor wherewith to multiply the error in the analysis.

In conclusion, while the evidence available seems to favor the inference that a "blythite" molecule enters into some mixed crystals of garnet to some extent, the mineral cannot be considered as firmly established until a satisfactory analytical procedure for the determination of manganic manganese in garnet is developed and used on a garnet possessing a considerable content of the manganic molecule.

GEOLOGY.—*An* Acanthoceras rhotomagense *fauna in the Cretaceous of the Western Interior.*[1] JOHN B. REESIDE, JR., U. S. Geological Survey.

Ammonites belonging to the genus *Acanthoceras* in the strict sense, that is, to the group of *A. rhotomagense* Defrance, have been reported from the Woodbine sand and basal Eagle Ford clay of Texas.[2] They have not been recorded, so far as the writer knows, in the literature dealing with the Cretaceous of the Western Interior province. A note of two localities in this region where *Acanthoceras* aff. *A. rhotomagense* occurs is therefore of interest to students of Cretaceous stratigraphy and faunas.

One locality, in south-central Colorado, found by G. K. Gilbert, many years ago lies 1½ miles west of the head of Rock Canyon, in Pueblo County southwest of Pueblo, and the horizon of the fossils is in the Graneros shale about 60 feet above the Dakota sandstone. Most of the species associated with the *Acanthoceras* are undescribed pelecypods and gastropods, though unnamed species of *Turrilites* and *Mammites* (*Pseudaspidoceras*), and an engonoceratid are also represented by fragmentary or somewhat distorted specimens. The next underlying marine fauna is in the Purgatoire formation, beneath the Dakota sandstone, and is composed of Comanchean species. The next overlying fauna is in the Greenhorn limestone, about 150 feet higher in the section, though the intervening part of the Graneros shale has yielded *Exogyra suborbiculata* Lamarck, a small *Ostrea*, and *Inoceramus labiatus* Schlotheim. The Greenhorn limestone is 25 feet thick and contains *Inoceramus labiatus*, a new species of *Thomasites*, *Helicoceras corrugatum* Stanton, *Baculites gracilis* Shumard, "*Acanthoceras*" *coloradoense* Henderson, and *Metoicoceras whitei* Hyatt. Two hundred feet higher in the section, at the top of the Carlile shale, a fauna with

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[1] Published by permission of the Director, U. S. Geological Survey. Received Oct. 1, 1927

[2] RUDOLF LASSWITZ, *Die Kreide-ammoniten von Texas (Collectio F Roemer)* Geol Pal. Abh 10: 237 1904

GAYLE SCOTT, *Études stratigraphiques et paléontologiques sur les terrains crétacés du Texas* p. 136. Grenoble, 1926.

GAYLE SCOTT, *The Woodbine sand of Texas interpreted as a regressive phenomenon.* Bull. Am. Ass Petr Geol 10: 617 1926

Prionocyclus wyomingense Meek, *Ostrea lugubris* Conrad, and *Scaphites warreni* Meek and Hayden occurs. An expected intermediate fauna with *Prionotropis woolgari* Mantell (of Meek) has not been recognized.

The second locality, in middle western Colorado, about 7 miles west of Delta in Delta County, was first found by G. H. Stone and later rediscovered by H. J. Weeks. Here the horizons are in the upper sandstone and upper shale of the Dakota (?) sandstone, the lowest marine beds in the local Cretaceous section. The specimens of *Acanthoceras* are very rare and are accompanied only by an *Inoceramus* of the group of *I. crippsi* close to *I. belvuensis* Reeside. Some 75 feet higher in the section, in the Mancos shale, *Gryphaea newberryi* Stanton and *Inoceramus labiatus* occur, and 200 to 300 feet higher still, the *Prionocyclus* fauna. The basal part of the Mancos shale in adjacent areas in Colorado and eastern Utah has yielded *Exogyra suborbiculata*, *E. columbella* Meek, *Metoicoceras whitei*, and a species of *Mammites* (*Pseudaspidoceras?*). An interesting species at this horizon a little farther west is *Exogyra olisiponensis* Sharpe. The *Prionotropis woolgari* fauna has not been recognized in this second area.

The similarity in the sequence of faunas in the two areas makes it likely that the age of the beds containing the *Acanthoceras* is nearly the same and that the deposition of sandstone at the western locality began sometime after it had ceased at the eastern locality, the intervening time being represented by the 60 feet of lower Graneros shale between the *Acanthoceras* horizon and the Dakota sandstone.

The genus *Acanthoceras*, in the strict sense, has been universally considered to characterize the Cenomanian part of the Upper Cretaceous, and such species as *Metoicoceras whitei* the lower Turonian. The occurrence of *Acanthoceras* in the Western Interior region permits a more definite age assignment of the containing beds and a more definite correlation with the Gulf region and with other areas outside the United States.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

ENTOMOLOGICAL SOCIETY

393D MEETING

The 393d regular meeting was held May 5, 1927, in Room 43 of the National Museum. President J. A. HYSLOP presided. There were present 21 members and 13 visitors.

On request Dr. CARL JORDAN of the Tring Museum, a specialist in Lepidoptera, but who now has in preparation a monograph on fleas, discussed some of his recent work, contrasting it with former activities and dwelling upon some of the marked differences in the two lines of research. He reported that his monograph is well under way and he now has under consideration some seven hundred known species of fleas. He also touched on recent general studies by various investigators in Europe and America on the interrelationships of insects with other animal forms.

Dr. HOWARD, in commenting on Dr. Jordan's address, emphasized the importance of his work, and referred to their associations together in company with Dr. Schauss at the Oxford Congress, and expressed hope that Dr. Jordan would be here again in 1928.

Upon request another visitor, F. C BISHOPP, of the Bureau of Entomology located at Dallas, Texas, expressed his pleasure at being able to attend a meeting of our society and at the prospect of being able soon to attend these more regularly.

Program: Dr. W. E DOVE and Dr G. F. WHITE: *The creeping eruption.* (Illustrated.) It was pointed out that creeping eruption as defined in most text books is a human skin disease due to the migration of fly larvae in the skin. The recovered larvae in some instances have been identified as those of *Gastrophilus*, in others as *Hypoderma*. In still other cases no larva was found. There is, therefore, not a single creeping disease but a number of them. One of these creeping diseases occurring in the South Atlantic and Gulf States has been shown to be due not to a fly larva but to the larva of a nematode. It has been demonstrated further that the nematode in this instance is *Ancylostoma braziliense*, one of the dog and cat hookworms. Out of twenty-seven street dogs examined in Jacksonville, Florida, twenty-six were found infected with this worm The number of worms harbored by each dog varied from near fifty to more than five hundred. The potential infestation of an area is further indicated by the fact that each female worm may lay up to five thousand eggs per day.

Discussed by EWING, GAHAN, BAKER, BISHOPP, HOWARD, and HYSLOP.

Dr. P W. MASON: *A discussion on the specialization of aphids from general feeders to monoxenous feeders.* Evidence shows that aphids originated in north temperate regions. These early, primitive forms were general feeders on any existing vegetation From these heteroxenous feeders, they gradually evolved to dioxenous feeders, which condition is normal at the present time The next step will probably be to that of monoxenous feeders. Several examples were given of species which have already learned to live on one host, some of them having so lived since Tertiary times, when the alternate host was destroyed by glaciation. When migration finally ceases, each species which is now dioxenous will probably evolve into two species, one on the present primary and one on the present secondary host, if each host continues to exist.

Discussed by HYSLOP and BAKER.

Dr. ALDRICH reported the recent accession by the National Museum of a collection of Lepidoptera made by Henry F. Schoenborn, containing considerable European material noteworthy for range of distribution and for being especially well mounted. He also directed attention to and commented on a recently issued paper by C. H. T. Townsend, entitled "Synopse dos generos muscoideos da região tropical de America, com generos e especies novas." Dr. Aldrich further stated that he had for distribution on request separates of his recent Presidential address on "Limitations of taxonomy."

Dr. **Howard** stated that a letter just received from R. B. Coad at Tallulah, La., reported that though the laboratory force was safe, the flood waters were standing ten feet in depth all over the city of Tallulah, that airplanes recently used in boll weevil work were being used in flood rescue work. Some very interesting airplane photographs of the flooded areas were sent, showing refugees on elevations greatly resembling work of prehistoric mound builders. This suggested possibility that some of these mounds originally might have been constructed for use in periods of flood.

Dr. **Baker** reported the recent finding in Texas of the Mexican fruit fly or orange maggot, *Anastrepha ludens*, formerly *Trypeta ludens*.

H. S. **Barber** showed a map and discussed an apparently unrecorded trip made by Thomas Say into old Mexico. He quoted Dr. Schwarz's remark—"So! Say went to Mexico! I did not know that before"—made more than twenty years ago while discussing Thomas Say's remarks on the nest and honey of the types of his *Polistes mellifica* from near Jalapa, and on the behavior of the Indians from whom Say had obtained them. A number of other remarks by Say, occurring in various papers on shells, insects, and aboriginal artifacts were cited, indicating that about 1828 Thomas Say had collected at Vera Cruz, Jalapa, Mexico City, Tacuba and Chalco. Mr. Barber believes that the type localities of most of the species described by Say with the simple statement "Inhabits Mexico" are either in the vicinity of the City of Mexico, or along the old road from Vera Cruz to the capital. He showed a trail map of the routes and dates of Say's travels in so far as he had been able to learn them, which is expected to appear with more detailed notes in Entomological News.

Dr. H. **Morrison** directed attention to a meeting next week of the Indiana Academy of Sciences to be held at New Harmony, Indiana, the former home of Thomas Say, at which meeting this fact and Say's relation to American entomology would be emphasized.

J. S. **Wade**, *Recording Secretary*

SCIENTIFIC NOTES AND NEWS

Laurence La Forge has resigned as geologist in the U. S. Geological Survey.

S. F. **Schairer**, graduate student in the department of chemistry at Yale University, has joined the staff of the Geophysical Laboratory, Carnegie Institution of Washington.

Charles E. Resser and R. S. **Bassler** have returned from a field-study undertaken for the purpose of securing data necessary to complete a manuscript on the stratigraphy of the Cambrian of the Rocky Mountain region, left unfinished by the late Dr. C. D. Walcott. Their expedition traveled by motor-truck from the Wasatch Mountains in Utah to Alberta and British Columbia, and visited areas of Cambrian rocks at many places along the route.

Irwin R. Pohl, Division of Paleontology, U. S. National Museum, spent six weeks in July and August, in coöperation with the Milwaukee Public Museum, in a study of the lower Devonian of the lower Peninsula of Michigan and adjacent areas.

W. F. **Foshag** and **Harry Berman** have completed a trip to mining districts in northern Mexico, conducted under the auspices of the U. S. National Museum and the Mineralogical Museum of Harvard University, for the purpose of collecting exhibition specimens of the minerals of the region.

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PHYSICS.—*A magneto-electron theory of gravitation.*[1] Chester Snow. (Communicated by L. J. Briggs.)

This unified theory of gravitation and electricity originated in the discovery that in a world governed by the Lorentz theory (which neglects gravitation) no one could ever detect the "change" made by replacing every electric density ρ by $\rho \cos \alpha$ and adding a magnetic density $\rho \sin \alpha$, where α is an arbitrary constant. This gave rise to the conception of charge-magnitude with electric and magnetic charge as its two rectangular components, so to speak, the mode of resolution being unessential in the description of nature just as in the case of plane vector. The reflection that the Lorentz theory is not complete because it fails to include gravitation led to the following modification of this conception. The electric and magnetic charges of an electron being $\epsilon_1 < 0$ and $\lambda_1 > 0$ are of the form

$$\left.\begin{aligned} \epsilon_1 &= m_1 \cos(\pi - \alpha) = -\,m_1 \cos \alpha \\ \lambda_1 &= m_1 \sin(\pi - \alpha) = m_1 \sin \alpha \end{aligned}\right\} \quad (1)$$

For a proton

$$\left.\begin{aligned} \epsilon_2 &= m_2 \cos \alpha \\ \lambda_2 &= m_2 \sin \alpha \end{aligned}\right\} \quad (2)$$

These "charges" refer to their field-producing character in the Maxwell-Lorentz field equations. The necessary and sufficient conditions for the compatibility of these field equations enable us to draw three conclusions as to the constants m_1 and m_2.

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[1] Publication approved by the Director of the Bureau of Standards, Department of Commerce. This paper is a condensed statement of work presented before the Philosophical Society of Washington, October 15, 1927, and is to be published in more complete form as a Scientific Paper of the Bureau of Standards. Received Sept. 29, 1927.

1. They must be invariants.
2. They must be strictly conserved (even when we abandon the preliminary assumption that space-time is flat).
3. A physical velocity may be consistently assigned to them, which probably implies (1) and (2).

This is taken as a physical definition of "thing" or substance, without implying any metaphysical right to the exclusive "occupancy of space." It is important (for this theory) to emphasize the fact that the so-called electromagnetic energy, whose density is supposed to be $(E^2 + H^2)/8\pi$ and rate of flow $[E,H]/4\pi$, fails to qualify as substance under each of these three specifications. This concept arises when (and only when) we resort to physical averages of the field and treat matter in bulk.

Dynamics presents us with one and only one concept thus qualifying as substance, namely (invariant), mass. We accordingly identify "electricity" and "magnetism" with mass. They are measures of the strength or quantity of the substance in its field-producing character just as mass measures the same substance in its inertial aspect. If m_1 and m_2 are the masses of electrons and protons in grams, the equations (1) and (2) give their "charges" also in grams. The factor β which reduces grams to c.g.s. electrostatic units of charge is found in terms of the mass m_1 grams of an electron, its numerical electric charge ϵ, expressed in c.g s.e.s.u., and the constant of gravitation γ, by the relation

$$\beta = \frac{\epsilon}{m_1}\sqrt{1 + \gamma\frac{m_1^2}{\epsilon^2}} = 5.4 \times 10^{17} \tag{3}$$

This follows from the fact that α is defined by

$$\tan\alpha = \frac{m_1}{\epsilon}\gamma^{\frac{1}{2}} \text{ so that } \gamma = \beta^2 \sin^2\alpha \tag{4}$$

If ρ_1 denotes the mass density of electrons and u_1 their mean velocity, with ρ_2 and u_2 for protons, then the complete vector field E_0H_0 of the Maxwell-Lorentz field equations (macroscopic) may be resolved into two fields $E_0 = E + e$ and $H_0 = H_0 + h$, where E,H depend only upon the electrical aspect of mass and satisfy

$$\left.\begin{aligned}
\operatorname{curl} H - \frac{\dot{E}}{c} &= 4\pi\left(\rho_2 \frac{u_2}{c} - \rho_1 \frac{u_1}{c}\right)\cos\alpha \equiv 4\pi\sigma\frac{v}{c}\\
\operatorname{div} E &= 4\pi(\rho_2 - \rho_1)\cos\alpha \equiv 4\pi\sigma\\
\operatorname{curl} E + \frac{\dot{H}}{c} &= 0\\
\operatorname{div} H &= 0
\end{aligned}\right\} \quad (5)$$

The field e,h depends only upon the magnetic aspect of mass and satisfies

$$\left.\begin{aligned}
\operatorname{curl} h - \frac{e}{c} &= 0\\
\operatorname{div} e &= 0\\
\operatorname{curl} e + \frac{\dot{h}}{c} &= -4\pi\left(\rho_2 \frac{u_2}{c} + \rho_1 \frac{u_1}{c}\right)\sin\alpha \equiv -4\pi\mu\frac{u}{c}\\
\operatorname{div} h &= 4\pi(\rho_2 + \rho_1)\sin\alpha \equiv 4\pi\mu
\end{aligned}\right\} \quad (6)$$

The mean density of electricity σ and the mean electrical velocity v are abbreviations defined by equation (5). The mean density of magnetism $\mu > 0$ and the mean magnetic velocity u are defined by (6), the latter being also the mean mass velocity, since μ differs from the mean mass density ρ only in the fact that it is $\rho \sin \alpha$. In these equations the masses and hence charges are still being measured in grams. The theory is first presented on the assumption that space-time is flat. In a later formulation we abandon this assumption and view the first statement as an approximation.

It is the writer's belief that there are no phenomena, either electrical or gravitational, which give evidence of finite volume of electrons and protons. We may treat them as point-masses. The field vectors are regarded as conveniences for expressing the mutual influence of these masses *upon each other* and *no self-destructive field is introduced.* The fields mean nothing by themselves; it is only the equations of mutual influence which have a meaning. These equations show that if we could pin a proton down and neglect the space-time curvature it produces, a point-electron properly aimed would approach it with finite velocity, attaining the velocity of light at the moment it passed through the first point called a proton. On the views here presented, the two points might come to rest superposed in space-time so that if their masses were equal their electrical aspects would go into eclipse. Their inertial and magnetic (gravitational) aspects would still be distinct. The criticism that the field vectors E or h become meaningless as an electron is approached is therefore a criticism of the language used, although the description of mutual influence remains definite and finite. The volume integral of E^2 or h^2 over a volume including an electron has no mathematical or physical meaning. The corresponding physical averages $\bar{E}$, etc., of these vectors, which we use for certain ideal descriptions of matter, neglecting much of its internal motion, are finite and continuous by definition and lead to the concept of energy density *which is limited to macroscopic applications.*

In the microscopic treatment, the second members of the field equations (5) and (6) are all zero, and they are to be supplemented with a statement of the nature of the singularities in the usual manner as fluxes of E and h. Those conditions at infinity are also assumed which will exclude all solutions not of the form of retarded functions.

The expression for the force may be inferred from the suggestion made by equations (1) and (2) which is that electric and magnetic charges, although both measured in grams, are as distinct and independent aspects of mass as two perpendicular directions in a plane. In fact, while we are neglecting the curvature of space-time (so that with imaginary time its geometry is formally Euclidean), we may view it as part of a six-dimensional continuum formally Euclidean, the two new directions being called the electric and magnetic hyperdirections. They are perpendicular to each other and to space-time. The vector masses m_1 and m_2 are hypervelocities reckoned in units that are meaningless to us. All electrons and protons have the constant and unalterable components of hypervelocity as indicated in equations (1) and (2). When we ignore all the magnetic aspects of mass we are looking at a five-dimensional section which is perpendicular to the magnetic axis. With our electric component of mass we respond to the influences of other masses which are propagated to us with velocity c (in space-time) and which are produced solely by the electrical components of these masses, and represented by E,H. Our response in space-time is represented by the classical electromagnetic force $\beta^2\sigma \left\{E + \left[\frac{v}{c}, H\right]\right\}$.

In a five-dimensional section perpendicular to the electric axis all electrical aspects are ignored because they are invisible or end-on.

The field e,h arises solely from the magnetic aspect of masses, and the only component of our masses which respond to this is the magnetic component, the space-time effect being described by the force $\beta^2\mu\left\{h - \left[\frac{u}{c}, e\right]\right\}$, which is our way of describing the universal attraction of gravitation.

The mutual influences of bodies in space-time is described by the force density

$$f = \beta^2 \sigma \left\{E + \left[\frac{u}{c}, H\right]\right\} - \beta^2 \mu \left\{h - \left[\frac{u}{c}, e\right]\right\} \tag{7}$$

although in the hyperplane they appear to be without mutual influence. These two hyperdirections both stand in cylindrical relation to space-time and are so absolute as to be only pictorial for us whose experience is four-dimensional.

The meaning of equation (7) is that a particle with electric charge Q grams and mass M grams moves in the complete field according to the equation

$$M\frac{d}{dt}\frac{u}{\sqrt{1-\left(\frac{u}{c}\right)^2}} = \beta^2 Q\left\{E + \left[\frac{u}{c}, H\right]\right\} - \beta^2 M\left\{h - \left[\frac{u}{c}, e\right]\right\}\sin\alpha \tag{8}$$

If electric charge now be measured in c.g.s. electrostatic units in the field equations (5) and in the force expression (7) and (8), the term β^2 disappears and we have precisely the present-day theory of electricity, combined with a theory of gravitation. If the magnetic density μ be replaced by mass density ρ in the field equations (6), this replaces (by reason of equation (3)) the factor $\beta^2\mu$ by $\gamma\rho$ in (7) and $\beta^2 \sin\alpha$ by γ in (8). Gravitation is thus described in terms of two vectors, e,h, to which mass is related like magnetism, together with the force density $-\gamma\rho\left\{h - \left[\frac{u}{c}, e\right]\right\}$.

On the assumption that space-time is flat, the motion of a planet M with velocity u about a stationary sun M' is given by the vector equation

$$M\frac{d}{dt}\frac{u}{\sqrt{1-\left(\frac{u}{c}\right)^2}} = -\gamma\frac{M M'}{r^2}r_1 \tag{9}$$

where r_1 is a unit vector from M to M'. This differs from the Newtonian law only in that Newton's equations have on the left side $M\frac{du}{dt}$, the difference being about one part in a hundred million in the case of the earth's orbit. The perturbation of one planet on another differs from Newton's by the same order of magnitude. This views the sun's influence in rendering the geometry of space-time non-Galilean as smaller than hitherto imagined.

As we do not believe that space-time is flat, the foregoing presentation of the theory must be regarded as an approximation. Its complete statement is next made in tensor form, using for this purpose the unit of time $\frac{1}{c}$, but retaining the gram for mass and the e.s.u. for charge.

The electromagnetic field is defined as usual in terms of the antisymmetric tensor $F^{\mu\nu}$ derivable from an electrical four-potential ϕ_μ,

$$(F^{\mu\nu})_\nu = 4\pi J^\mu = 4\pi\sigma_0\frac{dx^\mu}{ds} \;---\; F_{\mu\nu} = \frac{\partial\phi_\mu}{\partial x^\nu} - \frac{\partial\phi_\nu}{\partial x^\mu} \tag{10}$$

where σ_0 is the proper density of electricity. The gravitational field is defined by a similar antisymmetric tensor $f^{\mu\nu}$

$$(f^{\mu\nu})_\nu = -4\pi P^\mu = -4\pi\rho_0\frac{dx^\mu}{ds} \;---\; f_{\mu\nu} = \frac{\partial\psi_\mu}{\partial x^\nu} - \frac{\partial\psi_\nu}{\partial x^\mu} \tag{11}$$

where ρ_0 is the proper density of mass. In the microscopic treatment σ_0 and ρ_0 in equations (10) and (11) are zero at all ordinary points, but these equations serve to indicate how the electrical and magnetic (gravitational) characters of the singularities determine the two fields. The motion of a particle with mass M grams and charge Q e.s.u. in these fields is determined by

$$\frac{d^2x^\mu}{ds^2} + \{\alpha\beta,\mu\}\frac{dx^\alpha}{ds}\cdot\frac{dx^\beta}{ds} = -\frac{1}{c^2}\left(\frac{Q}{M}F^\mu{}_\alpha + \gamma f^\mu{}_\alpha\right)\frac{dx^\alpha}{ds} \tag{12}$$

which shows that even when uncharged or in a purely gravitational field f^μ_ν, it departs widely from a geodetic world-line. The two types of field equations (10) and (11) involve the geometry through $\sqrt{-g}$. The dependence of the metric tensor $g_{\mu\nu}$ upon both the electrical and magnetic (gravitational) character of the singularities is assumed to be given by the radical modification of Einstein's equation

$$G_{\mu\nu} = 8\pi\frac{\gamma}{c^2}(E_{\mu\nu} - \gamma e_{\mu\nu}) \tag{13}$$

where

$$4\pi c^2 E_{\mu\nu} = -F_\mu^\alpha F_{\nu\alpha} + \frac{1}{4} g_{\mu\nu} F^{\alpha\beta} F_{\alpha\beta} \tag{14}$$

$$4\pi c^2 e_{\mu\nu} = -f_\mu^\alpha f_{\nu\alpha} + \frac{1}{4} g_{\mu\nu} f^{\alpha\beta} f_{\alpha\beta} \tag{15}$$

It is shown that from the two apparent conflicts with Einstein's original theory, which we have in equations (12) and (13), there arises a perfect observational harmony, the rotation of perihelion of the planets and the bending of the ordinary light ray $[E,H]/4\pi$ being practically the same.

A symmetrical static solution of (10), (11) and (13) is found for the case where $x^1, x^2, x^3, x^4 = r, \theta, \phi, t$ to be given by

$$\begin{gathered} ds^2 = -p^{-1}dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta \, d\phi^2 + p\,dt^2 \\ F^1{}_4 = -Qpr^{-2}, F^4{}_1 = -Qp^{-1}r^{-2}, f^1{}_4 = Mpr^{-2}, f^4{}_1 = Mp^{-1}r^{-2} \end{gathered} \tag{16}$$

where

$$p = 1 + 2\left[\frac{\gamma^{\frac{1}{2}} Q}{c^2} - \frac{\gamma M}{c^2}\right] r^{-1} - \left[\left(\frac{\gamma^{\frac{1}{2}} Q}{c^2}\right)^2 - \left(\frac{\gamma M}{c^2}\right)^2\right] r^{-2} \tag{17}$$

This suggests the amount of light-deflection to be expected in an electrostatic field. The gravitational light ray represented by the vector product $[h,e]/4\pi$ would be deflected the same as the ordinary ray $[E,H]/4\pi$ but the former is small beyond detection. The average equation for ideal continuous matter is

$$G_{\mu\nu} - \frac{1}{2} g_{\mu\nu} G = 8\pi \frac{\gamma}{c^4} T_{\mu\nu} = 8\pi \frac{\gamma}{c^2} (M_{\mu\nu} + E_{\mu\nu} - \gamma e_{\mu\nu}) \tag{18}$$

The fact that space-time is not flat, as indicated by the deflection of the light ray $[E,H]/4\pi$ in the sun's gravitational field h shows that the six-dimensional picture which the form of this theory suggests can not be formally Euclidean. It is possible that a six-dimensional geometry might be developed which would lead to equation (13) starting from a line element of the form

$$(d\tau)^2 = g_{\mu\nu} dx^\mu dx^\nu + (\phi_\mu dx^\mu + dx^5)^2 - (\psi_\mu dx^\mu + dx^6)^2 \tag{19}$$

where the summations in μ and ν are from 1 to 4 and the coefficients ϕ_μ and ψ_μ are the electrical and gravitational four-potentials, so that

$\phi_u\, dx^\mu$, $\psi_u\, dx^u$, and $g_{\mu\nu}\, dx^\mu\, dx^\nu$ are all invariant to transformations of the four space-time coordinates.[3]

GEOLOGY.—*The Upper Cretaceous section in the Colob Plateau, southwest Utah.*[1] G. B. RICHARDSON, U. S. Geological Survey.

The Colob Plateau lies in southwest Utah, in eastern Iron and Washington counties and western Kane County, and extends from Cedar City and Kanarraville on the west to Orderville and Upper Kanab on the east. The name applies specifically to the bench underlain by the Cretaceous rocks, with the Eocene rocks of the Pink Cliffs rising above to the level of the High Plateaus—here known as the Markagunt and Paunsagunt—and with the bold escarpment of Jurassic and probably Jurassic rocks in the White Cliffs descending at the outer margin to the deeply eroded Triassic red beds.

The Cretaceous deposits of Colob Plateau are of interest to geologists in that they are on the western border of outcrops of the Cretaceous of the Interior Province and were very likely near the margin of the Upper Cretaceous sea in which the deposits were laid down. Some information on the Cretaceous rocks of the region has been included in several papers[2] though with but little detail as to fossils and sequence of strata. The data presented here were gathered a number of years ago and a first draft of the paper has lain unpublished for some time. No description of the Cretaceous strata of the Colob region has appeared in the meanwhile, however, and, so far as the writer knows, no more recent field studies have been made. It seems desirable, therefore, to make available the data in hand.

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[3] With this form, the field equations (10), (11), and (13) show that $\overline{G}^{\mu\nu} - \frac{1}{2}\gamma^{\mu\nu}\overline{G}$ (for the six-space R_6) vanishes in all components in which space-time suffixes enter and the equations of motion (12) indicate that a charged particle follows a geodetic line in R_6. It also appears that the resolution of charge into electric and magnetic (gravitational) components is physically indeterminate, which means that we may choose those two perpendicular directions x^5 and x^6 arbitrarily in their plane, thus altering the form but not the content of our description of nature Certain other transformations such as $x = x'^5 + U\ (x^1, x^2, x^3, x^4)$ do not alter even the form of that description Electricity and gravitation combined are thus viewed as manifestations of the geometry of a six-dimensional world of which space and time are a part A relation of this proton to the hydrogen nucleus is suggested

[1] Published by permission of the Director, U. S Geological Survey. Received Sept. 30, 1927.

[2] C E DUTTON, *Geology of the High Plateaus of Utah.* 1880; T. W. STANTON, *The Colorado formation and its invertebrate fauna* U S. Geol Survey Bull **106**. 1893; W T LEE, *The Iron County coal field, Utah* U S Geol. Survey Bull. **316**. 1907; G. B. RICHARDSON, *The Harmony, Colob, and Kanab coal fields, southern Utah.* U. S. Geol. Survey Bull **341** 1909.

The Cretaceous strata of the Colob Plateau consist of 2500 to 3000 feet of buff to drab sandstones and shales, with subordinate lenses of gray limestone and, near the base, workable beds of coal. Approximately the lower three-fourths of these beds are of Colorado age and the uppermost part of Montana, probably late Montana, age. A generalized section follows:

GENERALIZED SECTION OF CRETACEOUS AND ASSOCIATED STRATA IN COLOB PLATEAU, UTAH

Wasatch formation:
  Varicolored beds of limestone, shale, and sandstone, conglomerate at base. Fresh water shells . . over 500 feet
Unconformity.
Montana group (probably later part):
  Buff sandstone and shale, conglomerate at base Plants and fresh water shells about 500 feet.
Unconformity.
Colorado group:
  Buff sandstone and drab shale in the east, as much as 1000 feet thick and of marine origin, hiatus in the west
  Drab marine shale in the east, as much as 1000 feet thick, changing to interbedded shale and sandstone in the west, with the shale of lesser importance
  Sandstone, shale, and coal; in the east 300 to 400 feet thick and non-marine, in the west, very much thicker and non-marine in lower part, marine in upper part. Conglomerate at base
  Total about 2500 feet
Unconformity
Morrison formation:
  Varicolored shale and sandstone with lenses of limestone and gypsum about 400 feet.
Unconformity.
San Rafael group:
  Massive gray limestone, subordinate lenses of gypsum. Marine shells about 400 feet.

The limestone of the San Rafael group yielded fossils identified by T. W. Stanton as *Trigonia* sp., *Plicatula* sp., *Cidaris?* sp., *Camptonectes* sp., and *Lima occidentalis* Meek and Hayden. These determine the age of the beds as Upper Jurassic. The overlying varicolored deposits have not yielded fossils but there is very little doubt that they belong to the Morrison formation. At present the Morrison formation is assigned by the U. S Geological Survey with doubt to the Cretaceous though many geologists believe it better placed in the late Jurassic.

The Upper Cretaceous strata lie unconformably upon the Morrison formation with an undulating contact. The basal member consists of a variable bed of conglomerate from 15 to 30 feet thick, composed of rounded pebbles of quartzite and limestone up to six inches in diameter. Fossil plants have been found not far above this bed[3] and marine shells of Colorado age occur still higher. Its exact age and relation to the similar units in other parts of Utah, often designated Dakota (?) sandstone, are not determinable. In this paper the conglomerate will be considered as basal Colorado.

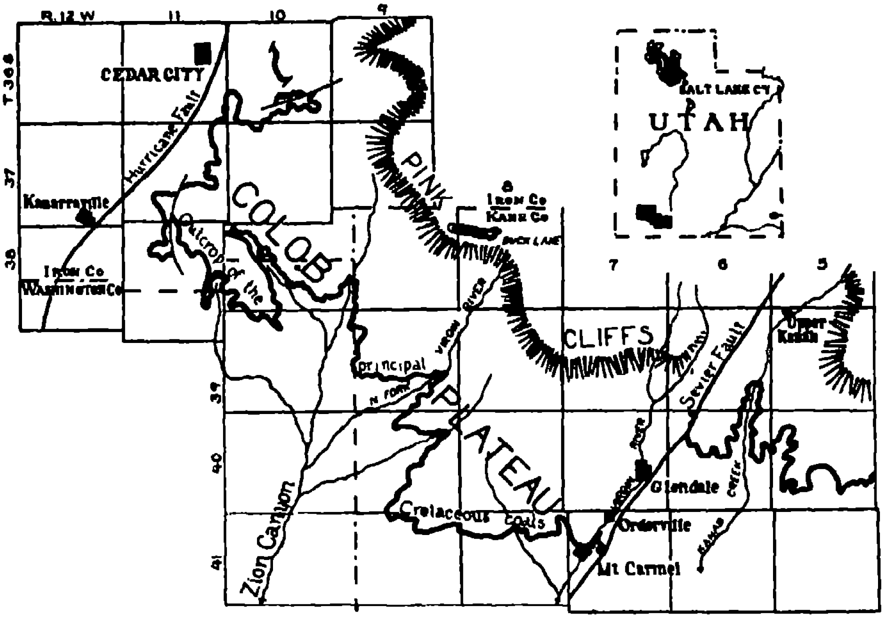

Figure 1.—Index map of Colob Plateau, southwest Utah

The rocks of Colorado age are about 2500 feet thick and above the basal conglomerate consist of buff, fine grained, quartz sandstones with much calcareous cement; buff, drab, and dark carbonaceous sandy and clayey shales; thin lenses of gray limestone; and one or more beds of coal within the lower 700 feet of the formation. The succession of strata is varied and even adjacent sections are unlike in detail. In general view, there is in the east a relatively thin coal-bearing basal sandstone unit, a middle thick shale unit, and an upper sandstone unit. Toward the west, the lower sandstone unit thickens at the expense of the shale unit and the shale unit itself

[3] T. W. Stanton, oral communication.

acquires sandstones. The upper unit is apparently absent through removal by erosion before the deposition of the overlying Montana beds. These changes result in the absence of the important shale unit in the western section, though it is conspicuous in the eastern section, as, for example, in Long and Kanab Valleys.

Faunally the Colorado group in the Colob Plateau may be divided into four units, the lower two of which are really two facies—in a broad view contemporaneous but in individual sections coming in succession. The coal-bearing beds in the lower part of the group contain littoral and brackish-water species, of which the most common, according to T. W. Stanton, to whom I am indebted for examining all of the collections of shells, are *Ostrea soleniscus* Meek, *Cyrena* sp., *Corbula nematophora* Meek, *Glauconia coalvillensis* Meek, *Eulimella funicula* Meek, *Admetopsis rhomboides* Meek, *A. subfusiformis* Meek. These species are associated at Coalville, Utah, with the principal coal bed, and most of them have been found also in the Oyster Ridge sandstone member of the Frontier formation in southwest Wyoming.

The beds above the coal-bearing zone, the lower part of the shale unit in the east and the upper part of the lower sandstone unit in the west, contain a purely marine fauna which includes among many other species the following: *Gryphaea newberryi* Stanton, *Inoceramus labiatus* Schlotheim, *Liopistha (Psilomya) meeki* White, *Turritella whitei* Stanton, *Baculites gracilis* Shumard, *Helicoceras pariense* White, *Metoicoceras whitei* Hyatt. This fauna occurs widespread in the lower Benton and equivalents, such as the basal Mancos shale of eastern Utah, New Mexico, and Colorado, and the Mowry shale and Frontier sandstone of central Wyoming. In these areas there is no zone of brackish-water fossils comparable to that described in the previous paragraph, the marine fauna constituting the first in the section, and the whole sequençe of deposits is thinner. It seems very likely therefore that the marine fauna in the region to the east is contemporaneous with both the brackish-water and marine faunas of Colob Plateau and that the differing thickness is due to relative distance from the source of the sediments.

Above the zone with *Metoicoceras* a zone of upper Benton age occurs, though it is not well represented in the collections. It is best distinguished by the presence of species of *Prionotropis*. This fauna is widespread also, occurring in the lower part of the Mancos shale, in the Carlile shale, and their equivalents. In the Colob Plateau this faunal unit is in the middle shale unit.

In the upper part of the Colorado group a fauna of brackish-water and littoral species occurs, closely related to and in part identical with that of the basal Colorado. Most of the genera are repeated and some of the species. However, at Coalville, near Manti, and in the Kaiparowits Plateau, Utah, a similar zone contains, in addition to the less distinctive species, some that indicate a Niobrara age, and it seems reasonable to infer that the upper zone in the Colorado group of Colob Plateau is likewise of Niobrara age. This zone is apparently missing in the western Colob, for the overlying fresh-water beds of Montana age descend so low in the section that they rest upon beds that include the horizons of the *Prionotropis* fauna.

Above the Colorado group lie several hundred feet of buff sandstone and shale of Montana age. A conglomerate of rounded pebbles of limestone and quartzite forms the basal unit and rests on an uneven surface of older beds. This conglomerate is about 20 feet thick on the average. These Montana beds contain fresh-water shells, among them *Unio holmesianus* White, *Viviparus panguitchensis* White, and species of *Planorbis* and *Physa*—species known in late Cretaceous beds elsewhere. Fossil plants also occur. F. H. Knowlton examined the collections and made tentative determinations, some of them being listed on page 470, but the flora is chiefly undescribed and gives little help in correlation. A similar late Montana unit of fresh water origin is present at many places in central and eastern Utah.

The next younger unit in the sequence is an irregular succession of limestone, sandstone, and shale of various colors. The contact with the underlying rocks is marked by a surface of erosion and a basal conglomerate of rounded pebbles of limestone, quartzite, and the underlying sandstone. Fossils are rare in these rocks and only fragments of *Viviparus* and *Unio* were obtained, but the characteristic peculiarities of lithologic constitution and color leave room for little doubt that they belong to the Eocene Wasatch formation so well developed in other parts of the high plateaus of Utah.

It is of interest to compare the sections in several other areas in Utah that lie near the western border of the Cretaceous of the Interior Province with that in the Colob Plateau. The section near Salina and Manti[4] shows almost exactly the same units as in the Colob. A thick lower unit, chiefly of sandstone, but containing also shale and conglomerate, has a lower Colorado marine fauna in the upper part.

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[4] E. M. SPIEKER and J. B. REESIDE, JR., *The Cretaceous shoreline in Utah.* Bull. Geol. Soc. Amer. 37: 429–438. 1926.

This is succeeded by shale with *Prionotropis*, and then a unit of sandstone and shale with a marine upper Colorado fauna. The Montana group is represented by a thick series of coarse-grained beds with a thin unit of coal-bearing strata near the top. The age of these Montana beds is not well established by fossils but it is believed that they are of late Montana age. At Coalville[5] the succession of strata is more complicated but the sequence of faunal units, and, in a general way, of lithologic units, is parallel to that at Salina and Manti and in the Colob. A lower unit of sandstone, conglomerate, and shale contains a lower Colorado fauna; a second of shale with minor sandstone and conglomerate contains a middle Colorado fauna with *Prionotropis;* and a third unit of sandstone and shale contains a Niobrara fauna. Above the upper Colorado beds lies a unit of rather coarse beds with a fresh-water fauna and a flora of Montana, probably late Montana, age. The succeeding beds at Coalville and at Salina and Manti are unconformable Wasatch deposits.

The following sections show the composition and approximate thickness of Cretaceous strata in Colob Plateau and the horizons at which fossils were collected:

LOCAL SECTIONS

SECTION OF CRETACEOUS ROCKS ON MAPLE CREEK (T. 36 S., R. 10 W.), EAST OF CEDAR CITY, UTAH

Wasatch formation:
Conglomerate, rounded pebbles of limestone and quartzite.
Unconformity

Montana group:	*Feet*
Concealed	110
Sandstone, massive buff	50
Concealed	90
Sandstone, massive buff, containing fragments of a dicotyledon, apparently *Platanus*	70
Concealed	45
Unconformity.	
Colorado group:	
Sandstone and shale	60
Shale, drab, with thin beds of sandstone	400
Sandstone, massive buff	150
Shale	70
Sandstone and shale, alternate thin beds	100
Sandstone and shale, containing many oysters	70
Sandstone, massive buff	45
Sandstone and shale, containing many oysters	60
Sandstone, massive buff	33
Sandstone, conglomeratic, containing scattered pebbles	42

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[5] C. H. WEGEMANN *The Coalville coal field.* U. S. Geol. Survey Bull. 581. 1915

Sandstone, massive buff (several layers full of oyster shells). About 500 feet above the base of the sandstone the following fossils were collected: *Gryphaea newberryi* Stanton, *Camptonectes platessa* White, *Liopistha* (*Psilomya*) *meeki* White, *Lunatia* sp., *Turritella whitei* Stanton, *Baculites gracilis* Shumard?, *Helicoceras pariense* White, *Metoicoceras whitei* Hyatt	1300
Sandstone, thin-bedded, fossiliferous	27
Sandstone, massive buff	38
Shale and marl containing the following fossils: *Cyrena* sp., *Corbula nematophora* Meek, *Glauconia coalvillensis* (Meek), *Eulimella funicula* Meek, *Admetopsis rhomboides* Meek, *Admetopsis subfusiformis* Meek	6
Coal and shale	2
Oyster bed	8
Sandstone, massive buff	45
Limestone, shaly, containing the following fossils: *Avicula gastrodes* Meek, *Barbatia micronema* Meek, *Cyrena* (?) sp., *Corbula nematophora* Meek, *Glauconia coalvillensis* (Meek), *Eulimella funicula* Meek, *Admetopsis rhomboides* Meek, *Admetopsis subfusiformis* Meek	3
Coal and shale	6
Sandstone, massive buff	
Base concealed.	
Total measured	2800

SECTION OF CRETACEOUS ROCKS SOUTH OF BLACK MOUNTAIN (T. 37 S., R. 10 W.), EAST OF KANARRAVILLE, UTAH

	Feet
Wasatch formation:	
Conglomerate, rounded pebbles of limestone and quartzite, 1 to 6 inches in diameter.	
Unconformity.	
Montana group:	
Concealed	250
Sandstone, buff	21
Shale, light	17
Sandstone, buff, containing the following plants: *Dammarites caudatus?* Lesq., *Podozamites oblongus?* Lesq., *Podozamites angustifolius?* (Eichw.) Schimp., *Platanus newberryana?* Heer, *Platanus* sp., cf. *P. primaeva* Lesq., *Betula* cf. *B. beatriciana* Lesq., *Menispermites ovalis?* Lesq., *Cinnamomum* sp., *Viburnum robustum* Lesq	11
Shale, light	15
Sandstone, buff	12
Shale, light	15
Unconformity.	
Colorado group:	
Sandstone, buff	11
Shale, drab	50
Sandstone, buff	3
Shale, drab	100
Sandstone, massive buff	15

Shale, drab, with thin beds of sandstone; contains the following fossils in the lower part: *Ostrea* sp., *Anomia* sp., *Modiola* sp., *Barbatia micronema* (Meek), *Cyrena* sp., *Corbula nematophora* Meek, *Eulimella funicula* Meek, *Chemitzia?* sp., *Admetopsis* sp	700
Sandstone, massive buff, containing the following fossils in the upper part: *Ostrea* sp., *Cyrena Glauconia coalvillensis* (Meek), *Admetopsis* sp	600
Shale, carbonaceous	17
Sandstone, buff	12
Shale, drab	35
Sandstone, buff	20
Concealed	80
Shale, carbonaceous	22
Sandstone, buff	25
Coal and shale	4
Sandstone, buff	30
Concealed	35
Shale, carbonaceous	45
Coal	6
Shale, drab	6
Sandstone, buff	8
Shale, drab	21
Sandstone, buff	5
Shale, drab	17
Sandstone, buff	15
Shale, drab	70
Sandstone, buff	6
Shale, variegated	45
Shale, buff	100
Sandstone and shale	15
Shale, buff	20
Sandstone, buff	8
Shale, drab	25
Sandstone, buff	22
Shale, sandy, carbonaceous	10
Shale, buff	100
Limestone	2
Shale, drab	11
Sandstone, buff	10
Shale, light	5
Sandstone, buff	11
Conglomerate, pebbles of limestone and quartzite	30
Total	2713

Unconformity.
Morrison formation.

Section of Cretaceous Rocks from the Head of Muddy Creek Southwest to North Fork of Virgin River (T. 39 S., R. 8 W.), North of Orderville, Utah

	Feet
Wasatch formation:	
Conglomerate, pebbles of quartzite, chert, sandstone and porphyry (base of Wasatch?).	
Unconformity.	
Montana group:	
Sandstone, buff	40
Concealed	75
Sandstone, buff	15
Shale, light	30
Sandstone, buff	11
Concealed	40
Shale, light	17
Sandstone, buff	26
Sandstone, with lenses of limestone, containing *Viviparus panguitchensis* White, *Viviparus* sp., *Physa* sp., *Planorbis* sp.	12
Concealed	150
Shale, light	15
Sandstone, buff	5
Shale, white	22
Sandstone, buff	11
Shale, light	18
Sandstone, buff	5
Shale, light	23
Sandstone, buff	16
Shale, purplish	5
Shale, light	17
Sandstone, buff	50
Shale, light	40
Sandstone, buff	41
Shale, light	11
Sandstone, buff	17
Concealed	15
Sandstone, buff	37
Sandstone, white	7
Sandstone, buff	15
Shale, light	20
Conglomerate, small rounded pebbles of limestone and quartzite	40
Unconformity.	
Colorado group:	
Sandstone, buff	22
Shale, light	40
Sandstone, buff	100
Shale, red	5
Sandstone, buff	100
Shale, light, streaked with red	20
Sandstone, buff	53
Concealed	50
Sandstone, buff	5
Concealed	25

Sandstone, buff	8
Concealed	20
Sandstone, massive buff	200
Shale, and thin-bedded sandstone	200
Sandstone, buff	40
Shale, drab	20
Sandstone, massive buff	110
Concealed, probably chiefly shale.	100
Shale, drab	60
Concealed, probably chiefly shale.	100
Shale, drab	70
Coal	2
Sandstone, white	50
Shale, drab	35
Concealed	125
Coal and shale.	8
Shale	50
Sandstone, white	40
Shale, purplish	5
Sandstone, white	15
Conglomerate	15
Total	2539

Unconformity.
Morrison formation.

GENERALIZED SECTION OF CRETACEOUS ROCKS IN VALLEY OF VIRGIN RIVER NEAR MOUNT CARMEL, UTAH

	Feet
Wasatch formation (?):	
Conglomerate.	
Unconformity.	
Montana group:	
Sandstone and shale, zone of fresh water shells and leaves	700
Conglomerate, pebbles of quartz, ½ to 1 inch in diameter	10
Unconformity	
Colorado group:	
Sandstone and shale, alternating beds, containing in the lower part: *Ostrea soleniscus* Meek, *Anomia* sp., *Cyrena* sp., *Thracia* sp., *Corbula nematophora* Meek.	1000
Shale (including a few thin beds of sandstone) containing near the top: *Prionotropis* sp., *Placenticeras* sp., and the following forms near the base: *Pecten* sp., *Avicula* sp., *Inoceramus labiatus* Schlotheim?, *Liopistha* (*Psilomya*) *meeki* White, *Dentalium* sp., *Turritella whitei* Stanton, *Baculites gracilis* Shumard?, *Metoicoceras whitei* Hyatt	700
Sandstone and shale, coal-bearing	400
Conglomerate, pebbles of limestone and quartzite, 1 to 6 inches in diameter	15
Total	2825

Unconformity.
Morrison formation.

Section of Cretaceous Rocks in Sink Valley, South of Upper Kanab, Utah

	Feet
Wasatch formation:	
Conglomerate, rounded pebbles of limestone and quartzite, 1 to 6 inches in diameter.	
Unconformity.	
Montana group:	
Sandstone, massive buff.	55
Shale, drab	27
Sandstone, massive buff	30
Shale, light	6
Sandstone, massive, buff, containing the following fossils: *Unio* (casts of two or more species), *Physa* sp., *Planorbis kanabensis* White, *Campeloma* (?) sp., *Viviparus panguitchensis* White	60
Concealed (probably shale)	27
Sandstone, massive buff	33
Conglomerate, rounded pebbles of limestone and quartzite, 1 to 2 inches in diameter.	27
Unconformity	
Colorado group:	
Sandstone, grayish-white	150
Shale, purplish-drab	20
Sandstone, massive buff	65
Concealed (probably shale)	60
Sandstone, massive buff	16
Concealed (probably shale).	50
Sandstone, massive buff, fine-grained	65
Sandstone, yellowish, coarse-grained	25
Sandstone, conglomeratic; pebbles small and scattered	5
Sandstone, massive, buff	50
Concealed (probably shale)	10
Sandstone, massive buff	11
Shale, carbonaceous	7
Sandstone, buff	11
Shale, light	8
Sandstone, containing oysters	11
Sandstone, massive buff	100
Shale, drab, clayey and sandy, and local thin beds of sandstone, containing the following fossils in the lower part: *Inoceramus* sp., *Lucina* sp., *Liopistha* (*Psilomya*) *meeki* White, *Turritella whitei* Stanton, *Aporrhais prolabiata* (White), *Sigaretus textilis* Stanton (?), *Baculites gracilis* Shumard (?), *Helicoceras pariense* White, *Metoicoceras whitei* Hyatt	1200
Sandstone, massive buff	60
Shale, carbonaceous	25
Sandstone, buff	6
Shale, light	11
Shale, carbonaceous	20
Sandstone, massive, buff	25
Shale, drab	80
Coal and shale	8
Concealed (probably shale)	40

Sandstone, gray	7
Conglomerate, rounded pebbles of limestone and quartzite	15
Total	2426

Unconformity.
Morrison formation.

SECTION OF CRETACEOUS ROCKS 5 MILES NORTHEAST OF UPPER KANAB, UTAH

	Feet
Montana group:	
Sandstone, white, containing thin beds of shale	150
Sandstone, buff to white, containing: *Unio* sp, *Planorbis kanabensis* White, *Viviparus panguitchensis* White, *Campeloma multilineata* M. & H.?, *Physa* sp	55
Shale, light	8
Sandstone, white	60
Sandstone, buff, containing the following leaves: *Cyperacites* sp., *Ficus* sp., *Laurus* sp	42
Sandstone, white	17
Conglomerate, pebbles of limestone and quartzite ½ to 2 inches in diameter	33
Unconformity.	
Colorado group:	
Sandstone, white	145
Concealed (probably shale)	20
Sandstone, buff	5
Concealed (probably chiefly shale)	100
Sandstone, buff	5
Shale, drab	40
Sandstone, massive, buff	10
Shale, drab	18
Sandstone, massive, white	33
Concealed (probably shale)	25
Sandstone, buff	20
Concealed (probably shale)	15
Sandstone, massive buff	55
Shale, light	20
Sandstone, massive, buff	15
Concealed	40
Shale, drab	33
Sandstone, pinkish	55
Shale, light	5
Sandstone, buff, coarse-grained; locally conglomeratic	52
Sandstone, buff	43
Shale, drab	34
Sandstone, massive, buff	18
Sandstone, fossiliferous; containing: *Ostrea soleniscus* Meek, *Anomia* sp., *Barbatia micronema* (Meek), *Cyrena* sp., *Corbula* sp., *Admetopsis rhomboides* Meek, *Chemnitzia* (?) sp., *Prionotropis* sp	22
Shale, light	5
Sandstone, massive buff	80
Shale, drab, clayey and sandy, with local thin beds of sandstone. (Same unit as 1200-foot shale in Sink Valley section, p. 473)	–
Total measured	1278

PALEONTOLOGY.—*Two new unionid pelecypods from the Upper Triassic.*[1] JOHN B. REESIDE, JR., U. S. Geological Survey.

Triassic unionid pelecypods of the United States include four species from the Dockum group of Texas described by Simpson[2] as *Unio subplanatus*, *U. dumblei*, *U. graciliratus*, and *U. dockumensis;* three species from the "Trias" (probably Chinle formation) of northwest New Mexico described by Meek[3] as *Unio cristonensis*, *U. gallinensis*, and *U. terrae-rubrae;* two species from the Triassic of the Connecticut Valley, *Unio emersoni* Troxell[4] and *U. wilbrahamensis* (Emerson),[5] six species from the Newark formation of eastern Pennsylvania described by Pilsbry[6] as *Diplodon pennsylvanicus*, *D. borealis*, *D. wanneri*, *D. carolus-simpsoni*, *D. yorkensis*, and *Mycetopoda diluculi;* and two species, also from Pennsylvania, described by Pilsbry[7] as *Naiadites triassicus* and *N. wanneri*. All of these are believed to be Upper Triassic.

Pilsbry considers *U. dumblei* and *U. graciliratus*, because of the radial beak sculpture, as probably referable to *Diplodon* of the South American family Mutelidae rather than to typical *Unio* of the Holarctic family Unionidae. He suggests that when well-preserved specimens are found probably all of the other Triassic species will show relationship with the South American family, and that the Unionidae proper, which certainly appear in the Morrison formation, will be found to represent a migrant element coming to North America from Asia in Jurassic time.

In the western region, in addition to the Dockum group, unionid pelecypods have been noted at many localities in Upper Triassic rocks.

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[1] Published by permission of the Director of the U S Geological Survey. Received Oct. 4, 1927

[2] C T SIMPSON, *Description of four new Triassic unios from the Staked Plains of Texas* Proc. U. S Nat Mus 18: 381–385 1896.

[3] F. B MEEK, *Description of three new species of Triassic unios from the Gallinas Range, New Mexico.* Ann Rept U S. Geol. Surv W. 100th Mer, Appendix LL, p. 83–84 1875

E. D. COPE, *The extinct Vertebrata.* Rept. U. S. Geol. Surv. W. 100th Mer. 4(2): 9 *pl. 23, f. 2–7* 1877

[4] E. L TROXELL, *Unios in the Triassic of Massachusetts.* Am. Journ Sci. (4) 38: 460–462. 1914.

[5] B K EMERSON, *A new bivalve from the Connecticut River Trias.* Am Journ. Sci. (4) 10: 58. 1900

[6] H. A PILSBRY in H. E WANNER, *Some faunal remains from the Trias of York County, Pennsylvania* Proc. Acad. Nat. Sci. Phila 73: 30–37 1921.

[7] H. A PILSBRY in H. E WANNER, *Some additional faunal remains from the Trias of York County, Pennsylvania.* Proc. Acad. Nat. Sci. Phila. 78: 26–27 1926.

The "Popo Agie" beds (Jelm formation), the Dolores formation, and particularly the Chinle formation have yielded them. These formations contain a similar fauna of vertebrates and are probably of about the same age. No unionids have been found in the earlier Triassic deposits.

A form from west Texas and one from northeastern Arizona, each represented by a single specimen in the collections of the U. S. National Museum, do not fit any of the described species and seem worthy of record as new. Both are of types not before noted in the western Triassic, though apparently paralleled by forms in the eastern region. Because of radial beak sculpture rather than concentric they should both be assigned to *Diplodon*, but the specimen from Texas seems to the writer to be very much like some of the highly sculptured types of Cretaceous Unionidae for which Pilsbry proposes the name *Proparreysia.*[6]

Diplodon? haroldi Reeside, n. sp.

Figure 1

Shell suboval, small; beak small, subcentral, posterior and anterior ends both broadly rounded.

Sculpture of two sets of moderately strong ridges intersecting at an angle of about 60° on a line passing from the beak to the basal margin slightly posterior to the middle of the shell The posterior slope has the strongest corrugations, the anterior and basal parts few or none. Basal part shows several coarse concentric ridges

Hinge not preserved.

Length and height, as preserved, 35 and 25 millimeters; probable complete length and height, 40 and 30 millimeters

Collected by Harold J Cook in 1925 in Mitchell County, Texas, in the southeast corner of the Staked Plains. Dockum group.

This species is distinguished by its suboval form and by its relatively complex sculpture, resembling in some respects that of *Diplodon wanneri* but recalling much more that of such later species as *Unio* (*Proparreysia*) *holmesianus* White.[6] It is really not very close to any of the described Triassic forms.

The associates of *D.? haroldi* at the locality of occurrence were *Unio dockumensis*, *U. graciliratus*, *U.* cf. *U. dumblei*, and some reptilian remains

Diplodon gregoryi Reeside, n. sp.

Figure 2

Shell small, suboval, beak fairly prominent, subcentral; anterior end narrowly rounded, posterior end rather broadly rounded

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[6] C. A. WHITE, *Contributions to paleontology. No 4. Laramie* 12th Ann. Rept. U. S Geol Surv Terr, p 67, *pl 22, f 4* 1880

Sculpture of about 15 nearly equal, broadly rounded radial ribs, with narrow shallow grooves between Concentric sculpture weak except on the basal part. The radial ribs are weak or absent on the basal part of the shell.

Hinge unknown.

Length and height, as preserved, 13 and 11 millimeters; probable complete length and height, 16 and 12 millimeters.

Collected by H. E. Gregory in 1911 in Beautiful Valley, Navajo Indian Reservation, Arizona. Shinarump conglomerate.

This species is characterized by its form and its radial sculpture. No close relatives are known in the western Triassic. In the eastern Triassic *Diplodon pennsylvanicus* seems to be the closest, though it differs sharply in the anterior position of the beak and in the outline of the valve. *D. borealis* has a different type of sculpture, with its broad flat ribs and very narrow interspaces.

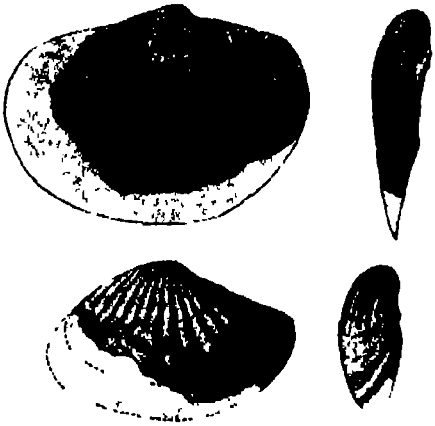

Figure 1.—*Diplodon? haroldi* Reeside, n sp, lateral and anterior views of type specimen, natural size (upper figures) Dockum group, Mitchell County, Texas U S. Nat Mus Cat No 73450

Diplodon gregoryi Reeside, n sp, lateral and anterior views of the type specimen, × 2 (lower figures) Shinarump conglomerate, Beautiful Valley, Arizona. U S Nat Mus Cat No 73451.

In the form and sculpture, *D. gregoryi* suggests strongly some marine species allied to *Cardita*, so much indeed that it was at first thought to be a marine species[9]—a very plausible assignment in view of the facts that carditoid shells are abundant in Mesozoic deposits, the specimen was accompanied by only fragments of other shells, and nothing remotely like it had been reported from fresh-water deposits in North America There seems little reason now to doubt that it is a fresh-water fossil, and that its habitat was such as to conform to the current interpretation of the conditions of deposition of the Shinarump conglomerate.

[9] H. E. GREGORY, *The Navajo Country* U S. Geol Surv. Prof. Paper 93: 41. 1917.

SCIENTIFIC NOTES AND NEWS

Prof. Leon W. Collet, Professor of Geology and former Dean of the Faculty of Science at the University of Geneva, Switzerland, who will fill Prof. R A Daly's chair at Harvard University during the first half year and during November will deliver a course of lectures at Princeton University, visited the Geological Survey in September and conferred on problems of tectonics and sedimentation with members of the Survey. Prof Collet will visit Washington again in November, at which time he will address the local geologists Prof Collet's new book on *The Structure of the Alps* has just been issued.

Dr E Seidl, of Berlin, mining engineer and geologist, known for his studies of the salt domes and potash mines of central Germany, in September presented to members of the U. S. Geological Survey his views on the bearing of salt structures on the interpretation of the structure of parts of the Alps.

Dr D J Mushketov, Director of the Geological Survey, U. S S. R , who is visiting the United States to gather data on organization, administration, methods of work, publication, costs, etc , in connection with geologic work, spent some days in early October at the U S. Geological Survey. He later attended the meeting of the Association of the State Geologists at Urbana, Illinois, and on November 2 spoke before the Geological Society at Washington

The National Academy of Sciences met at Urbana, Illinois, on Tuesday, Wednesday, and Thursday, October 18, 19, and 20 G P Merrill, U. S National Museum, David White, U. S. Geological Survey, and C S Hudson, Bureau of Standards, read papers and A L Day, Geophysical Laboratory, gave the evening lecture, open to the public, on the subject *The volcano problem*. Papers dealing with psychology and biology were given on Tuesday afternoon, botany and zoology in one section, and physics and chemistry in a second section, on Wednesday morning; and chemistry and geology on Thursday morning

The Association of State Geologists met with the National Academy at Urbana on Thursday morning, October 20, and on Thursday afternoon continued its meetings in the offices of the Illinois State Geological Survey The following day was given over to an excursion to points of geologic interest W. C Mendenhall and David White, of the U S Geological Survey, and G. P. Merrill, of the U S National Museum were in attendance

M R Campbell, of the U S Geological Survey, during the second week in October gave four lectures at the University of Pennsylvania as part of a comprehensive course on Fuel Engineering just instituted This course is to be given by some 50 specialists, each of whom will discuss the aspect of the subject with which he is particularly familiar. Mr. Campbell's lectures dealt with *Coal, lignite, and peat resources*

The meeting of the Section of Geodesy of the International Geodetic and Geophysical Union at Prague was the most successful one that has been held since the Union as organized at Brussels in 1919 Delegates were present from 25 countries and 4 other countries were represented by proxy The meeting of the Executive Committee was held on August 29 and 30, while the Section as a whole began sessions on August 31 The formal opening of the Union occurred on September 3. The outstanding report was that on work done by Dr. F A. Vening Meinesz, Engineer of the Dutch

Geodetic Commission, in determining gravity at sea in a submarine of the Dutch Navy In 1926 he traveled by submarine making gravity observations en route from Holland to Java, across the Atlantic and the Pacific and through the Panama Canal; in previous years he had made gravity observations from Holland to Java on a submarine through the Mediterranean Sea and the Indian Ocean. The reports from the United States and Canada showed much work done in the field and in the office since the Madrid reports and give accounts of new instruments and methods

In the Section of Terrestrial Magnetism and Atmospheric Electricity interesting reports were received from many of the 27 nations represented at the Congress. Proposed French work in Indo-China and in the Pacific was of special interest Reports from the United States, including that of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, were complete and the latter, especially, was filled with valuable material in regard to international work Important subjects discussed included magnetic characterization of days, adoption of Greenwich time in observatory publications, advancement of auroral studies for which a committee was appointed including Sir Frederick Stupart, and Commander N. H Heck, and geophysical methods of studying surface geological structures for which a committee including Mr J A Fleming was also selected. Dr Louis A Bauer was elected president of the section.

In the Section of Seismology national reports of considerable interest were presented, especially that of Dr Imamura for Japan who also discussed results obtained with the long period-seismograph. Reports showed that the United States is rapidly taking its proper place in the investigation of seismological problems, a report for the Government, submitted through the Coast and Geodetic Survey, gave a comprehensive statement of all the activities in the United States, governmental and otherwise Detailed reports described the reports of the Carnegie Institution of Washington and the Jesuit Seismological Association

The work of the Section of Oceanography was chiefly a statement of steps taken in the attempt to coordinate the activities of the Section with those of other organizations The possibilities and limitations of such cooperation were brought out · It was pointed out that a recent accomplishment of the Section was a preparation of lists of oceanographers and oceanographic institutions throughout the earth, publications of great value to those engaged in oceanographic work

With one exception eight sessions of the Meteorological Section were presided over by Sir Napier Shaw of London. A report of the Bureau of the Section showed that pyrheliometers had been purchased for installation in Samoa, Spitzbergen and Belgian Congo, and four special photometers designed by Richardson for measuring the Earth's albedo from airplanes were ready for distribution New subjects discussed included the publication of upper-air data, the adoption of the week as the unit of time for meteorological summaries and a common unitary system for all the sciences comprised in the Union. The American delegate, Dr H. H Kimball was named chairman of a commission to arrange for better standardization of instruments and methods employed in radiation measurements.

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GEOPHYSICS.—*A machine for measuring the depths of deep wells.*[1]

C. E. VAN ORSTRAND, U. S. Geological Survey.

The accurate and efficient measurement of the depths of deep wells is a problem of fundamental importance in the fields of science and engineering. Unfortunately, however, but little has been done to place the solution of this important problem on a strictly scientific basis—the methods of a quarter of a century ago, although recognized as extremely awkward and for the most part incorrect, are still in use.

The necessity of having a simple and accurate method of measuring the great depths to which thermometers are lowered into deep wells while making temperature tests has led me to attempt the development of apparatus which meets the fundamental requirements of simplicity and accuracy. The investigation to date has resulted in the apparatus shown in Figures 2 and 3. Incidentally, this apparatus may provide a simple means of obtaining the depths of geological formations, thus providing the geologist with accurate data on which to base his correlations.

It is not necessary to describe here other depth recording devices. They are quite generally of the type that may be called rigid in contradistinction to the type illustrated in Figures 2 and 3, in which it will be seen at once that flexibility is a predominant characteristic.

The measuring parts of the machine shown in Figures 2 and 3 consist of two flat faced metal wheels each with 2¼ inch face and 24 inch circumference. A revolution counter geared to each wheel records the depth in feet. One counter only is shown in the illustrations. Two small pulleys, 2¼ inches by 2¼ inches, attached to a triangular frame serve to keep the cable centered with respect to the two measuring wheels. By spreading the triangle at the base, the opening between the pulleys can be adjusted to a cable of any diameter while adjustment to center is easily made by sliding the triangular frame on the large base frame. The upper part of the base frame measures approximately 12 inches by 24 inches, thus permitting bailers of 6 or 8 inches diameter to pass through the center of the machine when the steel bars carrying the wheels and pulleys have been disconnected and spread apart by rotation outwards about their points of support. The steel tubes shown on the sides of the steel frame for the insertion of legs are not always needed—it is generally more satisfactory to mount the ends of the frame on 2 inch boards which in turn are tacked lightly to the floor of the derrick. Two spiral springs assist in keeping the measuring wheels in contact with the cable, and at the same time they permit a cable of varying diameter to pass between the wheels without interrupting the operation of the machine.

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[1] Published by permission of the Director, U. S. Geological Survey. Received October 15, 1927.

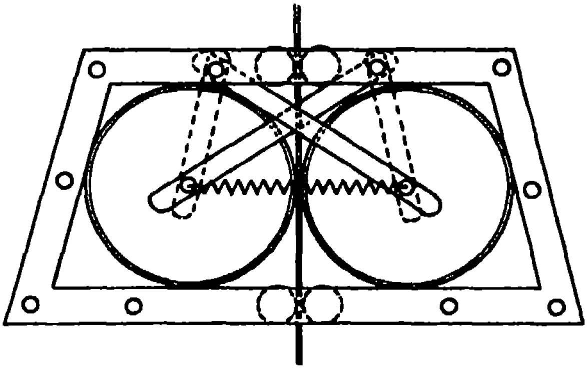

Figure 1 —Proposed arrangement of measuring wheels and guiding pulleys.

The apparatus described here is intended primarily for use while lowering the cable into the well, but, since the cable runs more uniformly while being removed from the well, it may be advisable to suspend the measuring parts as shown in Figure 1. Two methods of arranging the bars, represented respectively by the heavy and the dotted lines, are shown in the figure. A steel casting which permits of placing the measuring wheels above or below the plane of the casting may be preferable to the steel frame. The casting has the advantage of tending to keep the measuring wheels more nearly in the same vertical plane.

In operation the machine is centered with respect to the cable in its normal position while being lowered into or removed from the well. Ordinarily, this position is not in the center of the well. A level placed first longitudinally in contact with the upper tangent points of the measuring wheels and then transversely across the steel frame is used in making the final adjustment. Agreement of the records of the two counters at the end of the run is an exceedingly severe, but extremely useful check on the measurement.

The chief sources of error are longitudinal and transverse vibrations of the cable. Longitudinal vibrations are caused by the slipping of the coils of the cable on the reel, whereas transverse vibrations are the result of periodic impulses transmitted to the cable from the engine or other parts of the oil well machinery. Adhesion of the cable to the wall of the well and release from the same produce a combination of longitudinal and transverse vibrations that may be quite serious. Any one of the errors just described may be so serious as to prevent a machine from making an accurate record, but, for velocities of the cable not exceeding 200 feet per minute, these errors are not likely to be serious, and they can generally be eliminated by changing slightly the

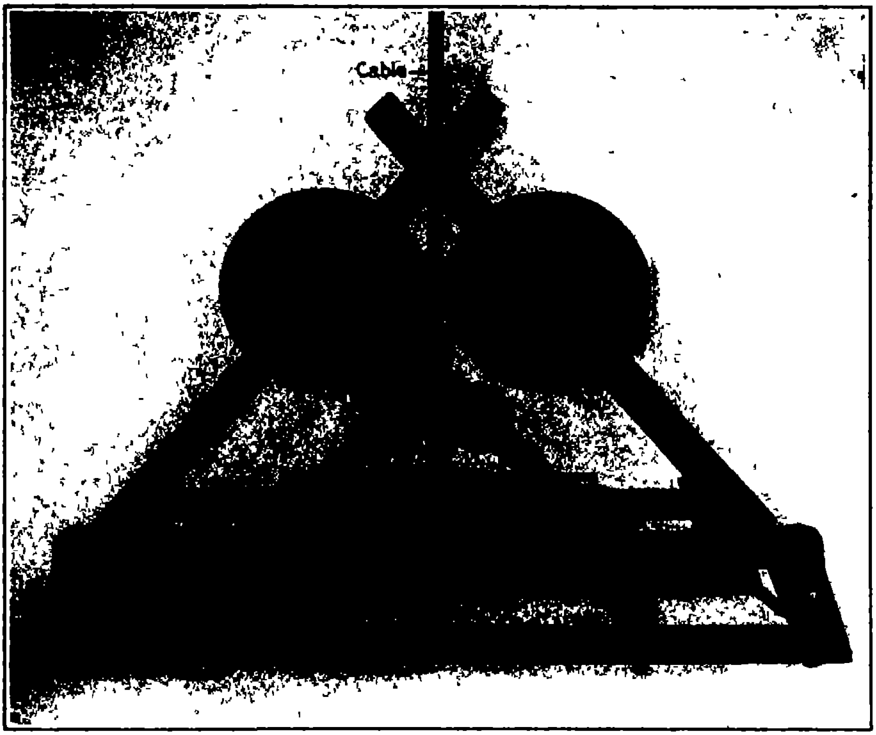

Figure 2.—Side view of depth recorder.

speed of the engine, or by adopting some other simple method of procedure.

In order to consider the possible discrepancies in the measurements resulting from sliding friction, let it be assumed that a well is measured first with a frictionless line and weight (W), the depths being recorded at the top of the well by means of a wheel which accurately records the length of line passing the tangent point of the wheel as shown in the sketch, Figure 4. The depths recorded by the wheel are identical whether the weight is lowered into or removed from the well. Assuming Hooke's Law, the true depth can be calculated from the observed depth on the basis that the tension in the line is due to a load equal to the weight (W) + ½ (weight of the line).

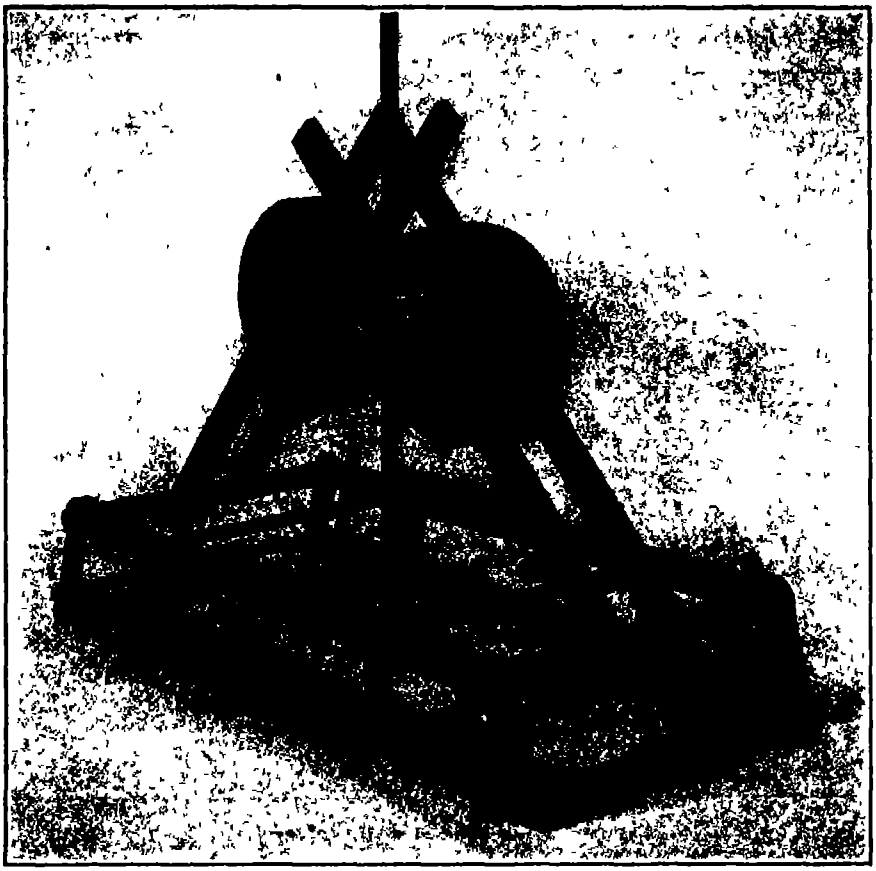

Figure 3.—Side and end view of depth-recorder without guiding pulley.

Assume a second case in which the frictional effects resulting from the movement of the line and weight (W) are identical in magnitude, but opposite in sign according as the cable is being raised or lowered. In this case the mean of the two observed depths corrected as before for a total load equal to the weight (W) + $\frac{1}{2}$ (weight of the line) leads to a correct result.

In all practical applications, however, it is obvious that the ideal conditions just described are not fulfilled—the probability that the frictional resistances will exactly compensate each other when the cable is moved in opposite directions is practically zero. Hence, it follows that the true depth of a well can not in general be determined from the mean of two observations made with a perfect recording machine at the top of the well. In measurements of one direction only, such as the well known method of "stringing over the derrick," the error is increased as frictional effects are not compensated. Frictional effects resulting from the motion of the line do not appear in measurements made with a metal tape, but the true depth of a well can not be determined from an observation of this kind for the reason that the variation in the tension of the tape from the top to the bottom of the well is unknown. The adhesive force between the tape and the wall of the well is usually very intense. It is probably caused chiefly by atmospheric pressure acting in conjunction with a film of moisture that occupies the space between the surface of the tape and that portion of the inner surface of the well with which it is in contact.

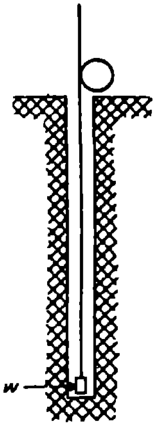

Figure 4 —Showing cable and measuring wheel.

The preceding theoretical considerations show that identity of measurements with a perfect recording machine at the top of a well is not to be expected. I have no information as to the magnitude of the error when the oil well cable is used as a measuring line. With a number 20 polished steel piano wire carrying a load of 7 pounds (3.2 kilograms), I have found differences of the order of magnitude of 0.5 foot per 1000 feet of measured length.[2] An exception to these observations is that measurements of depths of something like 1000 feet are frequently identical regardless of the direction of motion of the line, the wells in these instances being so nearly vertical over the first 1000 feet that the line does not come in contact with the wall of the casing.

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[2] *Apparatus for the measurement of temperatures in deep wells by means of maximum thermometers.* Econ Geol. 19: 247. April—May, 1924.

In a recent test near Johnstown, Pennsylvania, one counter of the depth recorder registered 6719 feet, the other 6721 feet; and in a test made a few years ago with a single measuring wheel[3] in deep well No. 1842 of The People's Natural Gas Company, located near Ligonier, Pennsylvania, the recorded depth was 7697 feet. This result compared favorably with the value 7705 feet obtained by The People's Natural Gas Company using the method of "stringing over the derrick." Other partial tests which have been made from time to time while lowering thermometers to different depths showed that discrepancies of 1 foot per 1000 feet of measured length are to be regarded as rather extreme. It has been impossible to make accurate comparisons, as an error of possibly 0.5 foot may have been made in reading the revolution counters.[4]

To test a depth recorder accurately, it would be necessary to measure off on the cable with a metal tape under given tension a given length as the cable passes in a vertical line from the top of the derrick to the floor. The total length of cable should be limited to a point such that frictional effects in the casing do not appear. I have not been able to make this test, but, judging from the agreement of the readings of the counters and the duplication of measurements to the same point on the cable, I am of the opinion that measurements of rather exceptional accuracy can be made with a machine embodying the fundamental requirements of stability, flexibility, and symmetrical distribution of load on the cable as contained in the apparatus shown in Figures 1, 2, and 3. An obvious advantage in the arrangement of parts shown in the figures is that the measuring wheels tend always to fall towards the cable without causing it to be displaced laterally from its normal position. The apparatus shown in Figures 2 and 3 is convenient for use on field trips when one desires occasionally to test a well in which the casing extends 2 or 3 feet above the level of the derrick floor. The more compact form shown in Figure 1 is probably more convenient for use while drilling or conducting other deep well operations. The supporting bars could be attached also to the lower part of the steel frame so as to make an arrangement of measuring wheels like that shown in the upper part of Figures 2 and 3.

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[3] See paper cited in footnote 2 for description of machine.

[4] Reset revolution counter. M34. Four figures. Veeder Mfg Co., Hartford, Conn.

Finally, identity of measurements independent of the direction of motion of the measuring line is an essential requirement of a perfect recording instrument when operating under conditions such that frictional forces in the well do not make their appearance. In practice, the mean of two readings obtained by running the cable in opposite directions appears to be the closest approximation that can be made to the true depth of a well.

I am especially indebted to Mr. John B. Tonkin, Vice President of The People's Natural Gas Company, Pittsburgh, Pa., and Mr. Kern Dodge of Philadelphia, Pa., for their generous coöperation in making the tests respectively at Ligonier and Johnstown, Pennsylvania. Mr. Dodge assisted personally in making the observations at Johnstown. The Ligonier well reached a total depth of 7756 feet making it, at the time of its completion, the deepest well in the world. This record of exceptional depth has since been surpassed by the deep well of the Chanslor-Canfield Midway Oil Company, Olinda 96, near Brea, California, the total depth as reported a few months ago being 8046 feet.

PALEONTOLOGY.—*Notes on foraminifera in the collection of Ehrenberg.*[1] J. A. CUSHMAN, Sharon, Massachusetts.

Between 1838 and 1872 Ehrenberg published many new generic names for fossil and recent foraminifera. Of these very few are accepted at present and indeed of many not enough has been known to determine their status in the accepted scheme of classification. In order to place these uncertain genera and to learn more about the species which should be considered genotypes of Ehrenberg's genera, I undertook a study of part of the original collection in Berlin. My thanks are due to Professor Pompecki, Rector of the University, for permission to study the collection and to Dr. Dietrich for his many courtesies.

As the collection has apparently not been consulted for a great many years, something of its general character may be noted. Ehrenberg's preparations, which include diatoms and foraminifera particularly, are chiefly balsam mounts. These are for the most part still in excellent condition, the balsam slightly yellowed with age, as is to be expected, but very clear indeed and showing no signs of deterioration, and the specimens in no wise impaired for study. The collection is contained

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[1] Received October 6, 1927

in a large number of book-like holders with the volume numbers and the general localities marked on the backs. In each volume are usually twelve double card-board trays, hinged at the back and numbered and named on the top. These trays, when lifted out and carefully opened, display the mounts themselves, made of small cover-glasses with balsam between and fastened to strips of mica, five mounts to each strip. The ends of the strip are inserted in slits in a large sheet which fits into the tray and often bears on the lower part a list of the included species. On the surface of the cover-glasses are very small rings of various colors, each ring containing figured or named specimens. With the collection is a catalogue, arranged evidently by Ehrenberg, giving the genera, and under each genus in alphabetical order the species, and for each species the book and tray in which it is to be found.

A collection of Ehrenberg's original drawings, beautifully done in pencil, ink, and water color, is also preserved. There are more than twenty-five hundred sheets of these drawings, many sheets with numerous figures. The drawings are accurate and much better executed than are the figures on the published plates. Each individual figure bears a notation in ink or pencil referring to the volume, tray, strip, slide, and colored ring, so that the original specimen may be very quickly found. At first the system would seem to be a complex one, but it is in reality very workable, as the catalogue gives under each species a column referring to the original sheet of drawings on which the species appears.

The specimens may be studied both by transmitted light, the method by which Ehrenberg largely worked, and by reflected light, by which it is possible to get a good idea of the surface.

In the following pages a few notes are given on certain species of especial interest in settling questions of nomenclature which relate to American species.

The genus *Grammostomum* of Ehrenberg has as its first figured species *G. tenue* Ehrenberg (Abhandl. K. Akad. Wiss. Berlin, 1841, p. 426, pl. III, vii, f. 45). This then is the species which is the genotype. A study of this figured specimen shows it to be a *Bolivina*, and *Grammostomum* Ehrenberg, 1841, becomes a synonym of *Bolivina* d'Orbigny, 1839. The other two species named in 1841 were not figured by Ehrenberg, and *Grammostomum tenue* Ehrenberg must stand as the only choice. Later many different things were referred to *Grammostomum* by Ehrenberg.

Spirillina Ehrenberg, 1841, has as its genotype *S. vivipara* Ehrenberg, a recent species with the type from Vera Cruz. An examination of the original specimen shows that it is as figured by Ehrenberg and as understood by later authors—with a proloculum and long planispirally coiled second chamber, the wall calcareous and perforate. The species name is derived from the occurrence of two young specimens in the parent test, a feature which shows excellently in the mounted specimen.

Allotheca Ehrenberg, 1841, is a monotypic genus, the genotype being *A. megathyra* Ehrenberg (Abhandl. K. Akad. Wiss. Berlin, 1841, p. 426, pl. III, vii, f. 49). Sherborn gives a note in his *Index*, "= Planorb. farcata, Young; with coarse pores." A study of the original figured specimen seems to place it under *Discorbis* Lamarck, 1804, and therefore *Allotheca* Ehrenberg should be considered a synonym of *Discorbis*.

Aristerospira Ehrenberg, 1858, had five species which were later figured (1873). In the order of the figures on the plate (Abhandl. K. Akad. Wiss. Berlin, 1872 (1873), pl. XI) these are *Aristerospira isoderma* Ehrenberg, *A. laevigata*, Ehrenberg, *A. globularia* Ehrenberg, *A. alloderma* Ehrenberg, and *A. platypora* Ehrenberg. I examined the types of all of these species, and found that they are to be referred to *Discorbis* Lamarck, of which *Aristerospira* becomes a synonym. The genotype of *Aristerospira* is *A. isoderma* Ehrenberg, selected because it is the first of the original species figured.

Pylodexia Ehrenberg, 1858, had two species at the time of description, of which *P. tetratrias* Ehrenberg was later figured and is therefore chosen as the genotype. A study of the types of this species shows it to be a *Globigerina*. One of the specimens, evidently microspheric, shows the "*Pulvinulina*"-like young as also figured by Rhumbler and others. On the original sheet of drawings this was marked in ink "*Globigerina*," evidently by Ehrenberg. *Pylodexia* Ehrenberg is therefore a synonym of *Globigerina* d'Orbigny.

Strophoconus Ehrenberg, 1843, had several species, the first of which figured, *S. auricula* Ehrenberg (*Mikrogeologie*, 1854, pl. XX, ii, f. 2), should be designated as the genotype. It is a young *Virgulina*, as noted by Sherborn.

Aspidospira Ehrenberg, 1844, had no species figured until the illustration in 1854 of *A. saxipara* Ehrenberg (*Mikrogeologie*, 1854, pl. XXXII, ii, f. 38). This is the common *Anomalina* of the Cretaceous of America, not the same as "*Planulina ariminensis*" as given by

Sherborn in his *Index*. By reflected light the type specimen figured by Ehrenberg is seen to have a raised suture about the middle part. As drawn by Ehrenberg the earlier chambers are not correct and the suture really represents the raised area about the center. The specimen is too thick and opaque to show the inner chambers pictured in the figure.

Porospira Ehrenberg, 1844, had several species, but the first of these figured, *P. comes* Ehrenberg (*Mikrogeologie*, 1854, pl. XXI, f. 93), is taken as the genotype. An examination of the type shows it to be an *Anomalina*, and *Porospira* becomes a synonym of that genus.

Proroporus Ehrenberg, 1844, is really a monotypic genus, as it had but a single species, *P. lingua*, figured later (*Mikrogeologie*, 1854, pl. XXI, f. 83). The type of this genotype species, examined in Berlin, shows the aperture to extend to the inner margin of the last-formed chamber and the species is therefore a true *Bolivina*. The published figure shows a costate surface but neither the type specimen nor Ehrenberg's original drawing show this. *Proroporus* Ehrenberg must therefore be placed as an exact synonym of *Bolivina* and can not be used for those species which tend to become uniserial (See *Loxostomum*).

Heterohelix Ehrenberg, 1843, was later changed by Ehrenberg to *Spiroplecta* but *Heterohelix* must stand as the generic name The genotype is *H. americana* Ehrenberg. The slide is marked "Kreide von obern Mississippi in Amerika." The young shell is planispiral, the test clearly calcareous and not arenaceous. It is a species of the American Cretaceous.

Cenchridium Ehrenberg, 1845, had as the only species *C. sphaerula* Ehrenberg. The original specimen and original unpublished drawing show it to be an *Entosolenia*.

Heterostomum Ehrenberg, 1854, has as its genotype *H. cyclostomum* Ehrenberg, the first figured species. This is a very poor specimen from the Chalk of Gravesend, smooth, and possibly a *Guembelina* but not certainly.

Pleurites Ehrenberg, 1854, has as the first species figured *P. cretae* Ehrenberg (*Mikrogeologie*, 1854, pl. XXVII, f. 32), which may be taken as the genotype. The type specimen has a smooth surface with the aperture and triserial form of *Bulimina*. *Pleurites* should be placed under that genus as a synonym.

Loxostomum Ehrenberg, 1854, has as the species first figured *L. subrostratum* Ehrenberg (*Mikrogeologie*, 1854, pl. XXVII, f. 19), which is chosen as the genotype. The type specimen in the Ehrenberg collection, from Meudon, is biserial throughout, with the aperture in the early portion as in *Bolivina*, later above the base of the inner margin and tending to become uniserial. The test is calcareous and not as given in Sherborn's *Index*, "Bigenerine *Text. agglutinans*." The name *Loxostomum* should therefore be used for those forms, derived from *Bolivina*, in which the aperture becomes terminal away from the inner margin. It will take the place of *Proroporus* Ehrenberg, as at present used, which, as already noted, is an exact synonym of *Bolivina*.

Notes were made on many other genera of Ehrenberg and on the American species figured by him in Plate XXXII of the *Mikrogeologie* but these will be left for a later paper.

BOTANY.—*Mosses from Ecuador, collected in 1918 by Dr. J. N Rose.*[1] R. S. WILLIAMS, New York Botanical Garden. (Communicated by WILLIAM R. MAXON.)

This lot of 49 species of mosses, obtained incidentally while making general collections of phanerogams and ferns in Ecuador, is of course but a fraction of the moss flora that may be found in any favorable tropical region where the mountains reach heights far above snowline. As will be seen, the greater number of species in the list are from the town of Huigra and vicinity, at about 9,000 feet elevation. Mosses often flourish in the tropics, however, from a few hundred feet above sea level to at least 16,000 or 17,000 feet, or nearly to the line of perpetual snow, and a collector able to give all his time to this one class of plants in a region where, from the same starting point, he might often make easy walking trips in a day to orange groves in one direction or to perpetual snows in the other, would soon find himself in possession of a wonderful variety of species.

In this list, oddly enough, the 49 species are distributed among no fewer than 37 genera. The genus *Campylopus* is not represented at all, although it is widely distributed in South America, some 21 species, for example, being already known from the neighboring country of Venezuela. *Fissidens*, here represented by a single collection, has 16 or more species in Venezuela, and *Macromitrium* about the same number.

The collection numbers cited in parentheses below are those given by Dr. Rose. He was assisted by his son, George Rose, and A. Pachano.

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[1] Received October 11, 1927.

FISSIDENS CRISPUS Mont.
Vicinity of Huigra, 9,000 ft., Sept. 4 (23650).
PLEUROCHAETE LUTEOLA (Besch.) Thér.
Trichostomum luteolum Besch. Prod. Bryol. Mex. 34. 1871.
Vicinity of Cuenca, Sept. 17–24 (24038).
LEPTODONTIUM ACUTIFOLIUM Mitt.
Cañar, Sept. 16 (23661).
LEPTODONTIUM LUTEUM (Tayl.) Hampe.
Vicinity of Portovelo, Oct. 5–15 (24039).
LEPTODONTIUM SULPHUREUM (C. M.) Mitt.
Vicinity of Portovelo, Oct. 6–15 (24040).
TORTULA DECOLORANS (Hampe) Mitt.
Tixan, 9,200 ft., Aug. 23 (23635).
TORTULA PICHINCHENSIS (Tayl.) Mitt.
Vicinity of Zaragura, Sept. 27 (23675).
TORTULA REPLICATA (Tayl.) Mitt.
Vicinity of Huigra, Sept. 7 (23639, 23653, 23655). Vicinity of Cuenca, Sept. 17–24 (23670).
RHACOMITRIUM CRISPIPILUM (Tayl.) Jaeg.
Vicinity of Loja, Sept. 29–Oct. 3 (24041).
ORTHOTRICHUM PUNGENS Mitt.
Vicinity of Cuenca, Sept. 17–24 (24042).

Macromitrium huigrense, sp. nov.

Pseudoautoicous. Male plants minute, scarcely 0.5 mm. high, the flower composed of about 8 ovate, acute to rather obtuse, very mamillose-celled leaves, crenulate on the border and partly costate, inclosing a few small antheridia. Fertile plants with creeping stems and stout, erect branches mostly 1–2 cm. high; branch leaves crowded, 4–5.5 mm. long, appressed in the lower part when dry, the points spreading–flexuous, more or less twisted and sometimes undulate, long-lanceolate from a slightly narrowed base, plicate or keeled along the costa, the margins slightly crenulate along the middle, the apiculate point serrulate, costa slender, about 40μ wide near the base, nearly or quite percurrent; cells of upper part of leaf mamillose on both sides, the median scarcely elongate, about 6μ wide by 6–9μ long, in rows and somewhat furrowed between; basal cells much longer, with thickened and pitted walls often bearing prominent, scattered papillae over the surface; perichaetial leaves much like those of the branches but broader and smooth in the basal part; seta 14–18 mm. long, very rough throughout and twisted in the upper part when dry; capsule ovate, 8-ribbed when dry, about 2 mm. long without lid, with stomata in three rows at its base, the conical lid with erect beak a little over 1 mm. long; preperistome of several rows of rather large, pale cells; peristome double, the outer of blunt teeth, at first united nearly to their apex, the outer surface finely punctate; inner peristome paler, about the height of the outer, the basal membrane extending about one-third up, the segments split into somewhat lanceolate, often irregular and curving points; spores rough, 35–40μ in diameter; calyptra deeply fissured about the base and bearing prominent but rather scattered hairs over its surface.

Vicinity of Huigra, Ecuador, at 9,500 ft. elevation, Sept. 3, 1918, *J. N. & George Rose* 23645, type.

This apparently undescribed species has much the appearance of *M.*

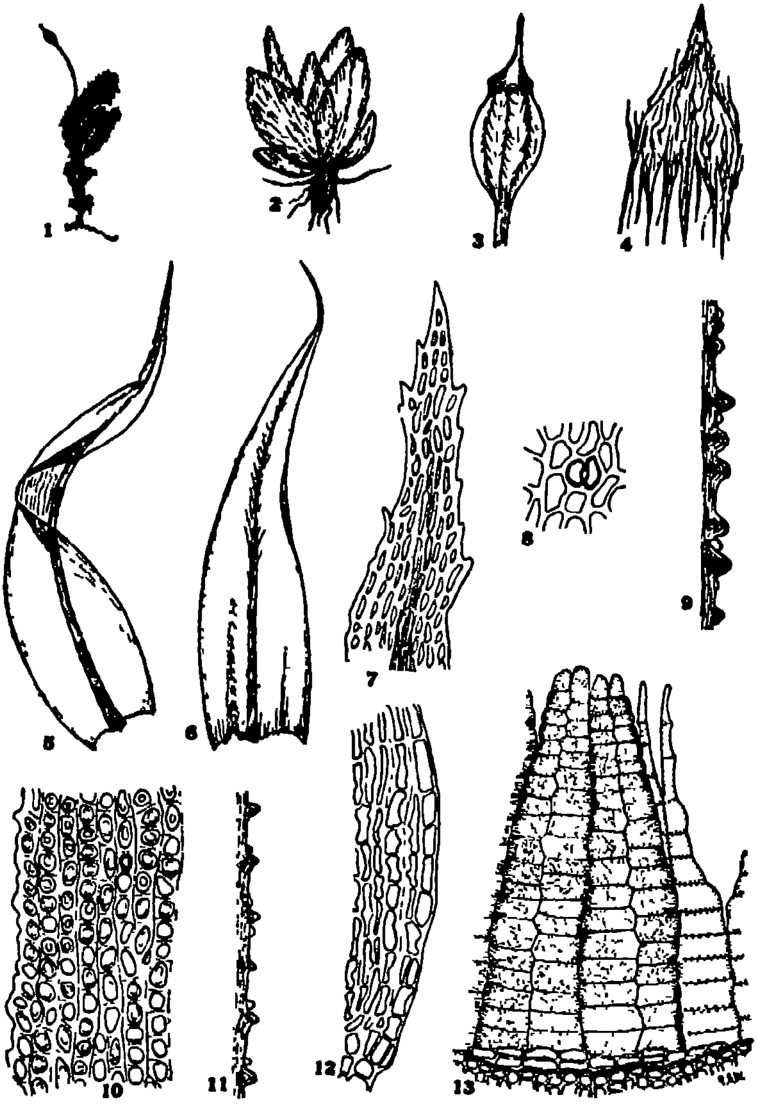

Figure A. *Macromitrium huigrense*, sp. nov.

1. Fruiting plant, about natural size
2. Male plant, × 40.
3. Capsule, × 8
4. Calyptra, × 8.
5. Stem leaf, × 8
6. Perichaetial leaf, × 8.
7. Apex of stem leaf, × 200
8. Stoma, × 180.
9. Part of pedicel showing papillae, × 200.
10. Median cells of stem leaf, × 200.
11. Surface near base of leaf showing papillae, × 200.
12. Leaf margin at base, × 200
13. Part of peristome, × 150.

proliferum Mitt., but the latter has a smooth pedicel. Except for the hairy calyptra it also somewhat resembles *M. subscabrum* Mitt.

Funaria calvescens Schwaegr.
Vicinity of Huigra, Aug. 16 (23636).
Mielichhoferia Lindigii Hampe.
Along railway, Sassa to Cotopaxi, Oct. 26 (23684).
Acidodontium exaltatum Spruce.
Vicinity of Huigra, at 6,000 ft. altitude, Aug. 18 (23634); 5,800 ft., Sept. 3 (23641); 8,500 ft., Sept. 2 (23647); 8,800 ft., Sept. 4 (23649).
Acidodontium seminerve Hook. & Wils.
Vicinity of Huigra, at 8,000 ft. altitude, Sept. 4 (23646).
Bryum argenteum L.
Vicinity of Cuenca, Sept. 17–24 (23666, 23673). Vicinity of Loja, Sept. 29–Oct. 3 (23679).
Bryum Crugeri Hampe.
Vicinity of Huigra, Sept. 6 (23652).
Mnium ligulatum C. M.
Vicinity of Huigra, at 8,700 ft altitude, Sept. 7 (23648).
Polytrichadelphus aristatus (Hampe) Mitt.
Vicinity of Cumbe, Sept. 25 (23674). Zaragura, Sept. 27 (23677, 24044).
Pogonatum polycarpum (Sch.) Broth.
Near Cañar, Sept. 16 (24037).
Polytrichum antillarum Rich.
Vicinity of Azognes, Sept. 16 (23663) Vicinity of Cuenca, Sept. 17–24 (23667). Along railway, Sasso to Cotopaxi, Oct. 26 (23683). Vicinity of Huigra, 5,500 ft. elevation, Aug. (23638).
Hedwigia albicans (Web.) Lindb.
Vicinity of Cuenca, Sept. 17–24 (24045).
Rhacocarpus excisus (C. M.) Par.
Vicinity of Loja, Sept. 29–Oct. 3 (24002).
Prionodon luteovirens (Tayl.) Mitt.
Vicinity of Huigra, Oct. (24008, 24013).
Squamidium nigricans (Hook.) Broth.
Vicinity of Huigra, Sept. (24046).
Squamidium nitidum (Sull.) Broth.
Vicinity of Huigra, at 5,200 ft. elevation, Sept. 3 (23640).
Pilotrichella hexasticha (Schwaegr.) Jaeg.
Vicinity of Huigra, Oct. (24000).
Papillaria imponderosa (Tayl.) Broth.
Vicinity of Huigra, Oct. (24011).
Floribundaria tenuissima (Hook. & Wils.) Broth.
Vicinity of Huigra, Sept. (24047).
Lindigia aciculata (Tayl.) Jaeg.
Vicinity of Ayapamba, Oct. 15 (24048).
Meteoriopsis patula (Sw.) Broth.
Vicinity of Cuenca, Sept. 17–24 (24050). Vicinity of Huigra, Oct. (24049).
Neckera Jamesoni Tayl.
Vicinity of Huigra, Aug. (23656); Sept. 11 (24051); Oct. (24001).
Porotrichum Korthalsianum (Dz. & Mb.) Mitt.
Vicinity of Huigra, Oct. (24004).
Porotrichum longirostrum (Hook.) Mitt.
Vicinity of Huigra, Oct. (24003).

POROTRICHUM STRIATUM Mitt.
Vicinity of Huigra, at 9,000 ft. altitude, Sept. 7 (23651); Oct. (24006, 24014).
ENTODON BEYRICHII (Schwaegr.) C. M.
Vicinity of Huigra, Aug. 16 (23631).
ERYTHRODONTIUM LONGISETUM (Hook.) Par.
Vicinity of Huigra, Sept. (23658.) Vicinity of Cuenca, Sept. 17–24 (23668).

Rozea Roseorum, sp. nov.

Autoicous, the male flowers on the stem often near the base of the pedicel, about 0.2 mm. long, and consisting of pale, ecostate, ovate, lanceolate-pointed, nearly or quite entire leaves enclosing 6–8 antheridia. Plants in rather loose, thin cushions, with procumbent, slightly branching stems and distant, irregular branches, the latter mostly less than 1 cm. long; leaves rather cymbiform, scarcely plicate or recurved on the margins, narrowly ovate, acutely pointed and entire or minutely serrulate in the upper part, with costa vanishing near or a little above the middle of leaf; stem leaves 2–3 mm. long, somewhat secund and spreading, those of the branches a little smaller, nearly erect and rather closely imbricate when dry, somewhat spreading when moist; leaf-cells smooth, elongate, except the basal, the median about 6μ wide and up to 60μ long, slightly sinuous, with rounded ends and thin walls; the basal cells nearly square or transversely elongate, extending to the costa and upward for a distance of 15-25 cells in the margin, perichaetial leaves mostly entire, broadly lanceolate, with a pale, short costa, the inner a little shorter or sometimes longer than those of the stem; seta dark red, about 15 mm. long, capsule oblong to oblong-cylindric, 1 5–2 mm. long with the conical lid, the exothecal cells very irregular, more or less elongate, with thick walls, the stomata in 1 or 2 rows at the base, annulus none, peristome double, the teeth cross-striate on the outer face below, somewhat obliquely striate near the middle and papillose above, segments of inner peristome finely papillose, from a basilar membrane nearly one-third the height of the teeth, narrowly lanceolate from a broad base, not or very slightly split along the keel, often rather irregular, mostly a little more than half the height of the teeth and without cilia, spores minutely punctate, up to 28μ in diameter.

Vicinity of Huigra, Ecuador, Sept. 12, 1918, *J. N. & George Rose* 23657, type.

CYCLODICTYON ALBICANS (Sw.) Broth.
Vicinity of Huigra, Aug. (24052).
HOOKERIOPSIS ADUNCA (Mitt.) Jaeg.
Vicinity of Cuenca, Sept. 17–24 (24053).
LEPIDOPILUM INTERMEDIUM (C. M.) Mitt.
On bamboo, vicinity of Huigra, Sept. 13 (23659).
RHACOPILUM TOMENTOSUM (Sw.) Brid.
Vicinity of Huigra, Aug. (23632); Oct. (24007).
LESKEA GRACILLIMA Tayl.
Vicinity of Cuenca, Sept. 17–24 (23669).
RAUIA PLUMARIA (Mitt.) Broth.
Vicinity of Huigra, Sept. (24054).
THUIDIUM BRASILIENSE Mitt.
Vicinity of Portovelo, Oct. 6–15 (24055).

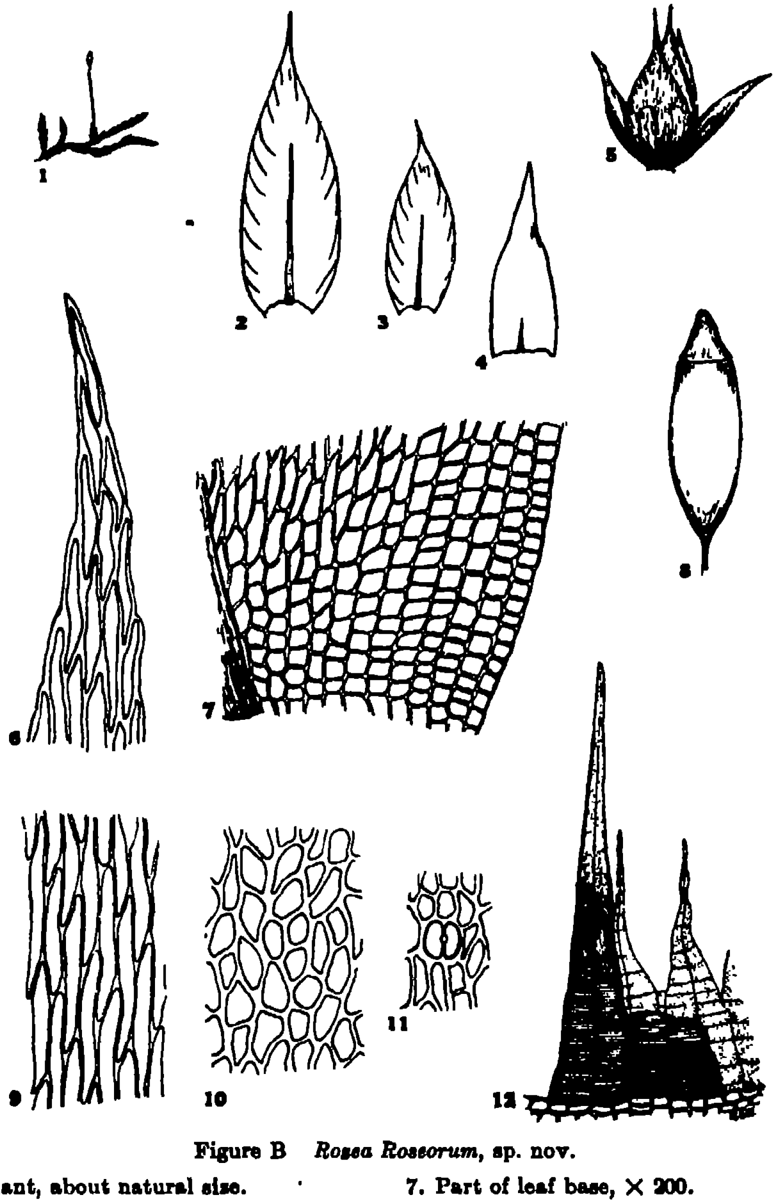

Figure B *Rossea Rosseorum*, sp. nov.

1. Plant, about natural size.
2, 3. Upper and lower stem leaves, × 12.
4. Inner perichaetial leaf, × 12
5. Male flower, × 12.
6. Apex of stem leaf, × 300.
7. Part of leaf base, × 200.
8. Capsule, × 18.
9. Median cells of leaf, × 300.
10. Median cells of capsule, × 200.
11. Stoma, × 200.
12. Part of peristome, × 150.

THUIDIUM CYLINDRACEUM Mitt.
Vicinity of Huigra, Sept. 7 (24057). Without special locality or date (24056).
THUIDIUM PERUVIANUM Mitt.
Vicinity of Portovelo, Oct. 6–15 (23680).
MITTENOTHAMNIUM ANDICOLA (Hook.) Card.
Vicinity of Huigra, Oct. (24012).
MITTENOTHAMNIUM REPTANS (Sw.) Card.
Vicinity of Huigra, Aug. (24058).

BOTANY.—*On a small collection of pteridophytes from the province of Kansu, China.*[1]

CARL CHRISTENSEN, Botanisk Museum, Copenhagen.

Although the fern flora of the southwestern provinces of China is now comparatively well known, very few species have been recorded hitherto from certain other provinces, notably Shan-si and Kansu. From the latter large province, which lies in the northwestern corner of China proper, the National Geographic Society's Central China Expedition, under the direction of F. R. Wulsin, has brought home a small collection of ferns gathered by Mr. R. C. Ching in 1923, which Dr. William R. Maxon, Associate Curator of the U. S. National Herbarium, has sent me for identification. The collection contains barely a score of species, but is nevertheless very interesting, owing to the fact that here, so far to the north, we still find the same mixture of different regional elements that is noted in the southern provinces. As might be expected, the northern types (nine species) are in a majority; but not less than six species are of southern relationship, one or two of them (*Drynaria, Polypodium*) being nearly tropical; five species are common Central East Asiatic forms; and two (*Athyrium* and *Adiantum pedatum*) are common to North America and eastern Asia.

The list of species is as follows, the new species being described at the end:

WOODSIA GLABELLA R. Br.
La Chang K'ou, near Sining; alt. 3060 m.; in shaded, very moist pockets of slopes (612).
WOODSIA LANOSA Hook.
La Chang K'ou, near Sining; alt. 3000 m.; common in crevices of shaded cliffs by a stream (630).
WOODSIA MACROSPORA C. Chr. & Maxon, sp. nov.
Gargannar, south of Old Taochow; alt. 3720 m.; crevices of rocky cliff, in a gorge; rare (906).

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[1] Received October 5, 1927

CYSTOPTERIS FRAGILIS (L.) Bernh.
Lan Ze Cheon K'ou, near Sining; alt. 2650 m.; shady cliffs; not common (592).

CYSTOPTERIS KANSUANA C. Chr., sp. nov.
La Chang-K'ou, near Sining; alt. 3060 m.; on densely shaded rocky cliff by a stream (631).

CYSTOPTERIS MONTANA (Lam.) Bernh.
Ta Hwa, near Pingfan; alt. 2940 m., common, under trees (553). Near Pingfan; alt. 2610 m.; common on moist, shaded cliffs (572).

DRYOPTERIS BARBIGERA (Hook.) Kuntze.
La Chang K'ou, near Sining; alt. 2910 m.; common on shaded rocky cliffs by a stream (635).

DRYOPTERIS GIRALDII (Christ) C. Chr., sp. nov.
Hsia Mo K'ou, near Lichen; alt. 2070 m.; common under trees (382).

DRYOPTERIS LINNAEANA C. Chr., var. LONGULA Christ.
Near Pingfan; alt. 2610 m.; common under trees, or on shaded moist rocky cliffs (573).

DRYOPTERIS ROBERTIANA (Hoffm.) C. Chr.
Gargannar, south of Old Taochow; alt. 3720 m.; in forest, at the foot of rocky cliffs; common (901).

POLYSTICHUM SHENSIENSE Christ.
Ta Hwa, near Pingfan; alt. 3210 m.; under bushes, in thin shade (518). La Chang K'ou, near Sining; alt. 3060 m.; shaded base of large rock on an exposed slope (609).

POLYSTICHUM SHENSIENSE Christ, var. TENERIFRONS C. Chr.
Archuen, south of Choni; alt. 4050 m.; common, in fir forest (979).

ASPLENIUM SARELII Hook.
Vicinity of Lichen, alt. 1860 m.; on shaded rocky cliff (307)

ATHYRIUM ACROSTICHOIDES (Sw.) Diels.
Gargannar, south of Old Taochow; alt. 4050 m.; mossy floor of dense fir and spruce forest; common (907).

ADIANTUM ROBOROWSKII Maxim.
Gargannar, south of Old Taochow, alt. 3780 m.; on rocky cliff, in forest; common (902).

ADIANTUM VENUSTUM Don.
Lan Ze Cheon K'ou, near Sining; alt. 2610 m.; large dense colonies in very moist forest (587).

ADIANTUM PEDATUM L. var. GLAUCINUM Christ.
Hsia Mo K'ou, near Lichen; alt. 1950 m.; in dense forest (326).

CHEILANTHES ARGENTEA (Gmel.) Kunze.
Lan Ze Cheon K'ou, near Sining; alt. 2610 m.; on a shaded rocky cliff (597).

CRYPTOGRAMME STELLERI (Gmel.) Prantl.
La Chang K'ou, near Sining; alt 3000 m.; moist crevices of shaded rock-slopes; common (614).

POLYPODIUM CLATHRATUM Clarke.
Near Pingfan; alt. 2610 m.; rocky crevice of shaded cliff, in moist gorge; common (571). Gargannar, south of Old Taochow; alt. 3750 m.; common on rocky cliffs in forest (903).

DRYNARIA SINICA Diels.
Moist exposed foothills, near Pingfan; alt. 2460 m.; forming dense carpet; common (481).

EQUISETUM RAMOSISSIMUM Desf.

Vicinity of Ningsia; alt. 1770 m.; common along mountain streams (204).

Woodsia macrospora C. Chr. & Maxon, sp. nov.

Rhizome suberect, stout, 2–3 cm. long, 1–1.5 cm. thick, becoming multicipital, densely clothed with thin, yellowish brown, lanceolate-subulate scales. Fronds numerous, laxly ascending, 8–15 cm. long, the stipes 2–8 cm long, slender, dull yellowish, scantily clothed with lax linear-subulate scales, these smaller upward, extending throughout the rachis, intermixed with long and short septate hairs; blades lance-oblong, slightly or not reduced at base, obtuse at apex, 6–9 cm. long, 2–2.5 cm. broad, pinnate, terminating abruptly in a subconform pinna, thin-herbaceous, delicately flaccid-hairy throughout, with shorter hairs intermixed; pinnae 6–8 pairs below the terminal one, subequal, 10–13 mm. long, 5–8 mm. broad, nearly horizontal, alternate to subopposite, sessile, ovate-oblong, subequally truncate-cordate at base, broadly rounded at apex, crenate; veins evident, once or twice forked; sori large, uniserial, medial; sporangia with a few flaccid hairs intermixed, large, globose, with a thick annulus, the spores very large (about 60μ in diameter, nearly black, globose, in lateral view coarsely verrucose, i.e., the exosporium furnished with reticulate crests.

Gargannar, south of Old Taochow; alt. 3720 m.; crevices of rocky cliff, in gorge; rare, August 29, 1923, *R. C. Ching* 906.

In general habit somewhat resembling *Woodsia Rosthornii* Diels (*W. Delavayi* Christ), which, however, is much more hairy and has the blade narrowed gradually downward, the apex pinnatifid. Otherwise our new species seems very unlike all other members of the genus, being especially remarkable for its impari-pinnate blade, large sporangia, and large black spores. The spores of *W. Andersoni* Christ, though similar, are scarcely verrucose, and that species is otherwise very different

Cystopteris kansuana C. Chr., sp. nov

Rhizome short-creeping, slender, 2–4 cm. long, about 1 mm. thick, flexuous, branched, very scantily paleaceous Fronds several, borne 2–5 mm. apart, laxly ascending, 8–16 cm. long, the stipes capillary, castaneous, nearly or quite as long as the blades, with a few thin scales at base, glabrous; blades lanceolate, long-acuminate to a subcaudate apex, 4–8 cm. long, 1 3–2 cm. broad below the middle, bipinnate, thin-herbaceous, glabrous; pinnae in 6 or 7 well-developed pairs below the pinnatifid apex, the lower ones at distances of 1–1.5 cm. apart, short-petiolulate, subopposite, 1 cm. long or less, deltoid, inequilateral at base, the costae winged; pinnules 1–3 pairs below the pinnatifid apex, the distal basal one much the largest, toothed, with the teeth cleft; veins raised beneath, pinnate in the larger segments, forked in the smaller ones, running out to the extreme sinus of the emarginations, these usually bordered by 2 unequal teeth; sori medial or inframedial; indusium ovate, entire, brown, persistent; spores immature.

La Chang K'ou, near Sining; alt. 3060 m.; on densely shaded rocky cliff, by a stream; *R. C. Ching* 631.

In several respects the present species is similar to small forms of *C. fragilis*, from which it differs in its distinctly unequal-sided pinnae and raised veins, and especially by the termination of the veins; these run invariably to the actual sinus of emarginations, whereas in *C. fragilis* they run out to the tip of the teeth. In *C. regia* (L.) Desv. also the veins run to marginal sinuses, but from this species *C. kansuana* is readily distinguished by its smaller size and less incised blades, and especially by its acroscopic basal pinnules, the pinnae being strongly inequilateral at base (the produced upper base truncate, the lower cuneate). *C. kansuana* finds a closer ally in *C. Mairei* Brause, from Yunnan, which has similarly unequal-sided pinnae with the veins running to emarginations, but that is a much larger plant, with stipe more than 20 cm. long and tripinnatifid blades.

Dryopteris (Eudryopteris) Giraldii (Christ) C. Chr., sp. nov.

Aspidium filixmas var. *Giraldii* Christ, Nuov. Giorn. Bot. Ital. n. s. **4**: 94. 1897.

Rhizome probably erect or oblique. Fronds suberect, up to 75 cm. long or more; stipe stramineous, up to 35 cm. long, rather freely but deciduously paleaceous, the scales thin, pale brown, narrowly lanceolate; blade broadly deltoid-ovate, about 40 cm. long and broad, bipinnate-pinnatifid, herbaceous, pale green, devoid of hairs, the rachis stramineous, glabrous, but more or less paleaceous by soft pale lanceolate-linear scales; pinnae about 10 pairs, alternate, the basal ones often a little shorter than the following, their lower side not or very slightly produced; largest pinnae about 20 cm. long, 6 cm. broad, petiolate (1 cm.), acuminate, unequal at base, the distal basal pinnule being somewhat elongate, the proximal one generally much shortened; pinnules 12–15 pairs, alternate, the larger ones short-petiolate, the upper sessile and decurrent (costae sometimes alate to the base), inequilateral at base, narrowly deltoid, acuminate, about 4 cm. long, 1 cm. broad or more, pinnatifid two-thirds or three-fourths the distance to the costa, or the larger ones of the lower pinnae near pinnate; segments close, oblique, oblong, ending in 4–6 unequal, sharp, often spinulose, falcate teeth; distal basal segment as a rule somewhat elongate, the proximal one oblique, often much shortened; veins pinnate in the lobes, the ultimate ones simple, terminating in a hydathode at the base of the teeth; sori borne on the middle of the anterior basal veinlets of the segments, solitary or the larger segments bearing 3–6; indusia reniform, about 1 mm. broad, persistent, glabrous, the margins slightly erose.

KANSU: Hsia Mo K'ou, near Lichen; alt. 2070 m.; common under trees; July 8, 1923; *R. C. Ching* 382.

SHEN-SI: Many collections, *Giraldi* (reported by Christ, loc. cit.); also *Purdom* 67.

SHAN-SI: Several localities, *Harry Smith* 5642, 6384, 6536, 7621.

SZE-CHUAN: *Harry Smith* 4704.

This species, which evidently is common in the mountains of Central China, is most distinct, but has been referred to various species. Numerous specimens collected in Shen-si Province by Giraldi, which are quite identical with those from Kansu and Shan-si Provinces, were regarded by Christ as a variety of *D. filixmas;* and I myself have referred with doubt certain material[8] from Shen-si to *D. marginata* (Wall.) Christ, and to the same species other specimens[9] from northern Sze-chuan which differ somewhat from *D. Giraldii*

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[8] Bot. Gaz. **52**: 332 1911.

[9] Med. Bot. Trädgård, Göteborg **1**: 61.

in their smaller sori and more acuminate segments, with shorter teeth, but are otherwise identical. From all the allies of *D. filixmas* with more divided blades (*D. marginata*, *D. fructuosa*, and others) *D. Giraldii* differs, however, very distinctly in its unequal-sided secondary pinnules. In this character it resembles *D. sparsa* (Ham.) Kuntze, and it is in my opinion a member of the small group of which that is the best known species. *D. sparsa* differs widely from *D. Giraldii* in its much thicker texture and in having the teeth not nearly so sharp.

To this group belong also *D. Sabaei* (Fr. & Sav.) C. Chr. and *D. subtripinnata* (Miq.) Kuntze, these, perhaps, forms of a single species which may include also *D. gymnophylla* (Baker) C Chr., and I think several Chinese specimens of *D. Giraldii* have actually been referred to *D. Sabaei*. That species differs in its smaller size and broad deltoid blades, with strongly basiscopic pinnae.

There remains yet to compare the new species with *D. laeta* (Komarov) C. Chr., which is unknown to me.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

956TH MEETING

The 956th meeting was held at the Cosmos Club April 17, 1927.

Program: Gregory Breit: *Wave mechanics.*

957TH MEETING

The 957th meeting was held at the Cosmos Club April 30, 1927.

Program: Howard S. Rappleye: *Some "fool proof" checks on computations.* A short discussion of various methods of checking certain types of calculations and their value in freeing the computation from blunders or mistakes of considerable size rather than checking absolutely the last figure of the result.

The idea was emphasized that a check computation which arrived at the final result by a route or method differing as widely as possible from that followed or used in the original calculation was most apt to render the computation free from "busts." Several examples of somewhat unusual checking methods were given.

A method of checking the computation of the observed seconds in observations taken with a direction theodolite was explained in detail as an example of the type of check which varies so widely from the original computation as to be a fair example of a "fool-proof" check.

P. Hidnert: *The thermal expansion of graphite.* (Tech. Pap. Bur. Stand. **21**: 223–230. 1927.)

C. H. Meyers and M. S. Van Dusen: *The vapor pressure of liquid carbon dioxide.* The vapor pressure of carbon dioxide was observed from the triple point (−56.59°C.) to the critical point (+31.1°C.). The results are based on observations of three samples which were in contact only with glass and mercury. Observations were made on five samples in metal containers but, because of unsatisfactory experimental conditions, the results obtained with these samples were given no weight in selecting the final values for the vapor pressure.

The material was prepared from pure sodium bicarbonate and pure sulphuric acid, and was purified by fractional sublimations and distillations.

Measurements of the triple point pressure (5.113 atmos.) were made, and the triple point temperature was calculated from an equation which represents the vapor pressure measurements.

Observations of the critical temperature (31.1°C.) and its corresponding pressure (72 95 atmos.) were also made.

A six constant equation was used to represent the results. It is believed that the values calculated from this equation are not in error by more than 1 part in 3000.

The results were compared with those of previous observers.

Tables were published which give the vapor pressure in atmospheres or millimeters of mercury for each degree Centigrade and in pounds per square inch for each degree Fahrenheit.

958TH MEETING

The 958th meeting was held at the Cosmos Club May 14, 1927.

Program: OSCAR S. ADAMS: *The readjustment of the western triangulation net.* During the past fifty years the first-order triangulation in the West has been gradually extended until now the total length of arcs is about twelve or thirteen thousand miles, or enough to reach half way around the earth at the equator. The earlier adjustments were made in separate sections as the work was finished and any loop closures that developed were adjusted into the last arc of the loop. To correct this obviously unjustifiable procedure, Major William Bowie, Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, early in 1924 devised a method of adjusment by the use of junction points and intermediate sections of arcs so that these closures could be distributed throughout the whole network and no section would be required to absorb an undue amount of the closures. By the use of the Laplace azimuths in the adjustments of the sections, the resulting closures of circuits have been reduced considerably from what were found when no such conditions were introduced. In the total number of loops that were adjusted, the largest closure is 31 feet in 950 miles, which amounts to about ten paces in a distance equal to that from Washington to Kansas City. Only two loop closures were greater than one part in 200,000 and the mean of all the closures was about one part in 450,000. The closure around the entire outer boundary is 33 feet, in a distance of 5300 miles, or approximately one part in 842,000.

N. H. HECK: *International attack on the earthquake problem.* From time to time there have been discussions on seismology before the Society, but the international background has never been presented.

The important contribution of Europe was discussed at considerable length.

Great Britain was the first to establish throughout the earth seismological stations with photographically-recording instruments and was among the first to study wave transmission and identify the various phases. Accordingly, this country is responsible for the long series of tables of epicenters of earthquakes from 1899 to the present, though since 1917 the International Seismological Summary has been prepared in Great Britain under the auspices of the International Geodetic and Geophysical Union.

The Germans have used visible-recording seismographs of great mass to eliminate the effect of friction. Important contributions from this country include mathematical studies and identification of phases resulting from reflection and refraction, also identification of surfaces of discontinuity and study of depth of focus. Preparation of travel-time curves and tables has been an important contribution.

The conception of a 60 km. layer beneath the continents is due to the work of the two Mohorovicics in Jugoslavia.

A very important Russian contribution was the Galitzin instrument, which in spite of certain difficulties is probably one of the best and most sensitive seismographs in existence today. Galitzin himself contributed an important treatise on transmission of elastic waves and the theory of the seismograph. French, Spanish and Italian contributions were discussed.

Accordingly, the European attack on the earthquake problem is chiefly from the mathematical and physical viewpoint. The study has been aided by the relative infrequency of earthquakes, but also handicapped by the comparative lack of data recorded as compared to other countries.

Coming to Asia, the Dutch East Indies have contributed by showing that submarine geology can be studied by means of seismograph investigations.

To supplement existing impressions of the great destruction in Japan accompanying the earthquake of September 1, 1923, a number of special instances were given as to the disturbances of activities of all sorts. Instances included complete destruction of the Hydrographic Office, the Land Office, partial destruction of the Imperial University at Tokyo, changes in Sagami Bay resulting from the raised shore and effect of land slides. A number of lantern slides depicting earth damage were shown.

The Japanese are placing considerable confidence in scientific investigation. They are replacing their undamped with damped instruments and have Galitzin instruments in Tokyo. They have a special apparatus for recording very long waves.

The situation in the rest of Asia, in Africa, and the American continents south of the United States was discussed, as well as Australia and the South Pacific.

In Canada, Dr. Klotz contributed important travel-time tables and an important investigation is going on at present.

In the United States, an early start was made with an American first suggesting the use of damping. However, the work failed to catch the imagination of the people and only moderate progress, scarcely worthy of this country, has been made. Recently the joint investigations in California by the Carnegie Institution of Washington, government bureaus, universities, and business institutions; the reorganization of the Jesuit Seismological Association and the installation of new instruments, adoption of improved methods and preparation of travel-time tables; the progress of the Coast and Geodetic Survey, which includes improved instruments in Porto Rico, Hawaii, and Alaska, as well as in certain places in the United States, all point to renewed activity in the subject which is likely to lead to important results. The Coast and Geodetic Survey is also preparing a quarterly report giving all earthquake shocks felt or recorded in the United States.

To a certain extent this growth may be trusted to continue, and the suggestion is made that physicists will find in this field ample opportunities for investigation and worth-while work which is contributing to the interests of humanity.

959TH MEETING

The 959th meeting was held at the Cosmos Club, May 28, 1927.

Program: C. S. CRAGOE: *The thermal properties of petroleum oils.*

G. R. WAITE and H. U. SVERDRUP: *Preliminary note on the electromotive forces possibly produced by the earth's rotating magnetic field, and on the observed diurnal variation of the atmospheric potential gradient.* The first part of the paper contains a formal computation of the electromotive forces which would be induced, upon certain hypotheses, at the magnetic poles of the earth on account of the rotation of its magnetic field. Supposing that these electromotive forces act upon charged particles entering the upper atmosphere and coming from the sun, it is possible to compute an incoming "current." The principal assumptions are: (1) That charged particles of a given sign are accelerated towards the earth when the electromotive forces have certain directions referred to the relative position of sun and earth, and (2) that the effect is of equal magnitude along the three rectangular axes. The "current" thus computed shows a diurnal variation and annual variations of phase-angle and of amplitude which are in remarkable agreement with corresponding variations of the atmospheric potential-gradient as actually determined from observations made at sea by the *Carnegie,* in the Arctic by the *Maude* expenditions, and at certain land stations. This agreement appears to be too good to be accidental; it is difficult, however, to develop a physical basis to explain, entirely satisfactorily, more than a quantitative relationship between the two phenomena.

H. E. MERWIN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Prof H. N. RUSSELL of Princeton University gave a talk at the Bureau of Standards on November 4, on *The structure of the elements of the iron group.*

J. W. FRENCH, Technical Director of Barr & Stroud, Ltd., manufacturers of military optical instruments, Glasgow, lectured on *Optical glass* at the Bureau of Standards on October 15.

The grasses collected on the South Atlantic Expedition, 1923–1926, of the Cleveland Museum of Natural History, exploring schooner BLOSSOM under the command of George Finlay Simmons, have been sent to the Grass Herbarium for study. Except for a few from Senegal the grasses were all collected on islands on both sides of the Atlantic. While the collection is not large there are many species not before recorded from Ascension, St. Helena, South Trinidad, Fernando Naronha, and the Cape Verde group. A complete set is deposited in the Grass Herbarium.

The American Ornithologists' Union held its annual meeting at the National Museum November 14 to 17. The officers for the year 1926–1927 were: Alexander Wetmore, Assistant Secretary of the Smithsonian Institution in charge of the National Museum, President; T. S. Palmer and W. L. McAtee, of the Biological Survey, Secretary and Treasurer. An account of the meeting will be published in a later number of the JOURNAL.

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GEOLOGY.—*A recent collection of late Pliocene invertebrates from the head-waters of the Amazon.*[1] JULIA GARDNER, U. S. Geological Survey.

Through the courtesy of Dr. Joseph T. Singewald, Jr., a collection of late Tertiary fossil invertebrates, chiefly Mollusca, made from deposits along the Peruvian head-waters of the Amazon during the field season of 1925, has been sent to the U. S. Geological Survey for examination. More than fifty years ago, in December, 1867, a similar fauna was collected at Pebas, in the same region, by James Orton, at that time the head of the Department of Geology at Vassar College. Professor Orton spent only a few hours at Pebas, but later and more extensive collections were made by Mr. Hauxwell, a naturalist of long residence in the Amazon Valley. Field observations were also made by Dr. Charles Frederick Hartt, who first went to Brazil as a member of Agassiz's staff on the Thayer expedition and later was appointed chief of Dom Pedro's Geological Commission. The Mollusca collected during these early explorations were distributed internationally and reports were made in scientific journals of the United States, England, and Austria and, very much later, of Brazil. The fauna was involved in questions of unusual interest—the age; the nature of the environment, whether dominantly fresh water, brackish, or marine; and the bearing of the deposits upon Agassiz's theory, later discarded, of the glacial origin of the Amazon valley. Gabb[2] considered the fauna "marine or perhaps rather a brackish water fauna" but did not commit himself upon the age further than the observation that the retention of the color markings of *Neritina* "would point to a very recent era." Conrad[3] believed the age "not later than Tertiary" and the biota either fresh or brackish but certainly not marine. He also observed that the condition of preservation of the double valves precluded the possibility of transportation for any distance from the spot in which the animal lived and died. Woodward[4] did not greatly concern himself with the age further than assigning the fauna to the Tertiary, but he refuted Agassiz's theory of the glacial origin of the deposits both by his own observations and by a communication from Professor Orton to the effect that "the perfect preservation of the most delicate parts, some specimens retaining even the epidermis, shows a quiet lake or estuary," and "that there certainly are no indications of a grinding glacier." Woodward was convinced of the estuarine ecology of the fauna and believed that the raised beaches observed by Darwin near the mouth of the Rio Plata and packed with *Azara labiata* d'Orbigny furnish an almost perfect analogy. Boettger[5] thought the Pebas deposits represented the old delta of the Marañon, and that in the depth and extent of the old delta we have a geologic chronometer. He concluded that the Pebas was an interior fauna living at the mouth of the Marañon during Oligocene or possibly even Eocene times. He further observed that the extreme variability of the few but abundant species is characteristic of all interior faunas. Barrington Brown,[6] while engaged in geological work for the Amazon Steam Navigation Company, traced the Pebas beds as far down as São Paulo, 150 miles below the Peruvian boundary and more than double that number below Pebas. He found them, too, 50 miles up from the mouth of the Javary, the stream entering the Marañon, as the Amazon is commonly known in that area, from the south and west and forming the boundary line between Peru and Brazil. He gave several sections, all of them indicating more or less clearly an interfingering series of blue clays and lignites, the clays commonly fossiliferous, the clay-lignite series overlain commonly to a considerable thickness by a mottled grey and red clay, the "Drift" of Agassiz. The fauna, collected at Canama, on the Javary, was studied by

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[1] Received November 3, 1927.

[2] W M. GABB, *Descriptions of fossils from the clay deposits of the Upper Amazon.* Am. Journ. Conch 4: 197–200. *pl. 16, f. 1–6.* 1869.

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[3] T A CONRAD, *Descriptions of new fossil shells of the Upper Amazon* Am Journ Conch 6: 192–198 *pl 10, 11; f. 1, 7, 8.* 1871

[4] HENRY WOODWARD, *The Tertiary shells of the Amazon Valley* Ann. Mag. Nat. Hist (4) 7: 59–64; 101–109 1871

[5] OSKAR BOETTGER, *Die Tertiärfauna von Pebas am oberen Maranon.* Kais —kön geol. Reichsanst , Jahrb 28: 485–504 *pl. 13–14.* 1878

[6] C. BARRINGTON BROWN, *On the Tertiary deposits on the Solimões and Javary Rivers in Brasil.* Quart. Journ. Geol. Soc. London 35: 76–81. 1879.

Etheridge,[7] who considered it Tertiary, fresh water, estuarine, possibly in part marine, and inferred from it a westward extension of the sea 1500 to 2000 miles west of the present debouchure of the Amazon. The Chara seeds common in the lignite are apparently referable to a genus widely distributed in stagnant, fresh, and brackish water. The excellent state of preservation of the wood, some of it only slightly altered, and the occasional coating of the woody parts of the surfaces with iron pyrites was noted by Barrington Brown. Interest in the Pebas fauna lapsed after 1879, but has been recently revived because of the economic possibilities, both in lignite and in the possible occurrence of petroleum. In 1924, De Oliveira Roxo[8] reprinted the figures and much of the text of the papers by Gabb, Etheridge, and Woodward and described two new species, one a *Planorbis*, the other assigned to *Pupura*, a marine genus. The figure is not convincing, however, and too much weight should not be given to the determination. He doubtless reflected, however, the consensus of later opinion when he deduced a comparatively late age for the fauna, the upper Pliocene.

The Singewald collections were made at the classic Pebas locality and from a number of other outcrops on the Marañon and Napo Rivers from which the series had not been previously reported. This gives a possible area of outcrop extending from above Iquitos, Peru, to São Paulo, Brazil, some 400 to 500 miles along the Marañon; some 50 miles up the Napo, which enters the Marañon from the north; and an almost equal distance up the Javary, which enters it from the south. The series of fine grained clays and lignites through which the Marañon cuts its channel from Iquitos to São Paulo is apparently similar to that reported along the front of the Andes from Peru, through Bolivia and well down into the Argentine.

Both the sediments and the state of preservation of the fauna—especially the common occurrence of the locked double valves of *Anisothyris*—indicate deposition in very quiet water. In some of the deposits there was not only no rapid movement but not even sufficient circulation to carry off the decaying animal matter, and the shale and its contained fauna present the characteristic features of the "black shale" described by Goldman[8]—a blue black shale heavily impregnated with iron pyrites and carrying a few but very abundant depauperate species. Such deposits are particularly characteristic of the mouths of rivers, where precipitation of suspended matter is suddenly accelerated not only by the loss of current velocity but also by the additional deposition induced by the salt water, particularly the flocculation of the organic matter.

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[7] R. ETHERIDGE, *Notes on the Mollusca collected by C. Barrington Brown, Esq , from the Tertiary deposits of Solimões and Javary Rivers, Brasil* Quart Journ Geol Soc London 35: 82–88 *pl. 7* 1879

[8] M G DE OLIVEIRA ROXO, *Contribuição a paleontologia do Valle do Amazonas.* Serv Geol Min Brasil, Bol 11: 1–52. 1924.

The entire Pebas fauna includes less than a score of species, most of them adaptable to either fresh or brackish water. One member of the *Potamides* group, described under the name *Cerithium coronatum* Etheridge, is not known to penetrate the upper courses of the rivers. Abundant small gastropods are referable to a group which favors the river just above the mouth. *Cypris* sp., the common fresh water ostracod, is present in considerable numbers. The most abundant and by far the most characteristic group, *Anisothyris*, a non-marine bivalve related to *Corbula*, has not been recognized in the Recent waters but finds a close analogue in *Azara labiata* d'Orbigny, abundant at the mouth of the Rio de la Plata. Darwin observed this species not only near Montevideo but also near San Pedro on the Parana, about 100 miles in an air line above Buenos Aires, where he noted vast numbers of *Azara labiata* packing the loose sands some 100 feet above the river bed. Mingled with the *Azara* of Montevideo, however, are numerous littoral species of which there is no trace in the Pebas fauna. Though the greater number of the Pebas species suggest the proximity of salt water, it does not seem probable that the Atlantic Ocean washed the foothills of the Andes so late as the Upper Pliocene. Even today the Amazon River suggests a series of inland lakes and this was probably true in the late Tertiary not only of the Amazon drainage but also of rivers to the south. The Andean streams must already have spread wide deltas, for the sediments are all fine. Across such flood plains the rivers wandered, leaving bayous and ox bows which perhaps became increasingly saline. The freest movement of the Pebas fauna seems to have been to the south, since there is probably a genetic relationship between two groups so unique and so strongly characterized as *Azara* and *Anisothyris*. Both *Anisothyris* and *Azara* are much restricted in their distribution. *Anisothyris* is characteristic of the head-waters of the Amazon, *Azara* of the lower La Plata. *Azara* is sparsely represented in Rio Grande do Sul but no trace of it has been recorded from the lower Amazon. The line of communication between the late Pliocene *Anisothyris* and the recent *Azara* was probably over the even now ill-defined divide between the upper Amazon and the La Plata. The close relationship between the fossil Mollusca of the head-waters of the Amazon and those now living in the lower La Plata is brought out much more emphatically by the fresh-water mussels of the Pebas fauna, which are now under investigation by William B. Marshall, Assistant Curator of the U. S. National Museum.

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[8] M. I. GOLDMAN, *"Black shale" formation in and about Chesapeake Bay.* Bull. Am. Assoc. Petr Geol. 8: 195–201. 1924.

The loosely organized drainage of the Upper La Plata and the Upper Amazon seems a more plausible explanation of the existing faunal relationships than the later erection of a barrier between the Upper and Lower Amazon. In any case there is little trace of any recent lineage of the late Tertiary Pebas faunas in the lower waters of the Amazon.

BOTANY.—Ruellia tuberosa *and a few of its close relatives.*[1] EMERY C. LEONARD, National Museum. (Communicated by WILLIAM R. MAXON).

Every monographer, no doubt, is familiar with the fact that in most of his special groups there will be found a species more troublesome and puzzling than any of the others, a species with an extensive range, with numerous variations, and, when treated in monographs, often with a long list of synonyms. *Scutellaria angustifolia* Pursh of the skullcaps, *Passiflora foetida* L. of the passionflowers, and *Ruellia tuberosa* L. may be cited as examples. If they are treated as polymorphic species their descriptions will be too indefinite or elastic to be of much scientific value. If they are subdivided into a number of "species," based on slight or variable characters, the nomenclature will be cumbersome and the keys difficult to follow, furthermore, the types of the segregated species will have been chosen to represent extremes of variation, and there will remain a number of poorly defined intermediate examples.

In highly variable species of this sort an intermediate course is often practicable. If abundant material is available, it will usually be possible to select suitable characters on which to base a central type as a nucleus, around which may be grouped the closely related forms, mostly as varieties. Often on following such a plan it will be found that these will conform more or less to definite geographic areas. In

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[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received October 27, 1927.

the present work, a paper preliminary to a revision of the American Ruellias, the complex "species" *Ruellia tuberosa* L. is treated in accordance with this plan.

Ruellia, of the family Acanthaceae, is a large and variable genus, which has sometimes been subdivided into numerous genera. The plants vary from small herbs a few centimeters high to large bushy shrubs; the flowers may be inconspicuous or large and showy; the corollas tubular or broadly campanulate, and in color mauve, white, yellow, pink, or bright crimson; the indument extremely variable. Yet constant throughout all the species stand the four perfect didymous stamens, with the filaments of each pair united at the base and decurrent on the corolla tube, the oblong symmetric anthers, and the cylindric or clavate capsules.

It may be interesting to call attention to the type of seeds found in this genus. They are invariably flat and suborbicular. Though covered by a closely adhering pubescence, the surface, when dry, appears glabrous; if moistened, the flattened inconspicuous covering swells into a woolly gelatinous mass.

KEY TO THE SPECIES

- Ovary and capsule glabrous.
  - Mature capsule slender, cylindric, 3 mm. broad, calyx ciliate or glabrate . . . . . . 1. *R. tuberosa.*
  - Mature capsule stipitate, 4 to 5 mm. broad; calyx more or less glandular-puberulent . . . . . . 2. *R. intermedia.*
- Ovary and capsule puberulent
  - Capsule eglandular or very sparingly glandular (North America). 3. *R. nudiflora.*
  - Capsule densely glandular-puberlent (South America) . 4. *R. lorentziana.*

1. RUELLIA TUBEROSA L. Sp. Pl. 634. 1753.
Ruellia clandestina L. Sp. Pl. 634. 1753.
Cryphiacanthus barbadensis Nees in DC. Prodr. 11: 197. 1847 (in part).

Roots clustered, thick-fibrous or fusiform; stems erect or ascending, usually branched, obscurely quadrangular, pilose or glabrate, bearing numerous minute cystoliths, petioles 0.5 cm. long, channeled, pilose or glabrate; leaf blades ovate or oblong, 2 to 11 cm. long, 1.5 to 6 cm. broad, obtuse at apex, abruptly narrowed toward base, undulate-crisped, rather thick, sparsely pilose or glabrous, the cystoliths numerous, 0.1 to 0.25 mm. long; flowers one to several, in erect or ascending dichotomous cymes, the peduncles up to 4 cm. long, glabrous or pilosulous, obscurely quadrangular, the cystoliths prominent, bracts linear, 3 to 8 mm. long; pedicels 5 to 10 mm. long, puberulent or glabrate; calyx 15 to 28 mm. long, the tube very short, the segments narrowly linear or subulate, ciliate or glabrous, often spreading; corolla showy, purple, 3 to 6 cm. long, sparsely puberulent, the tube about 1 cm. long, 3 mm. in diameter, the throat narrowly campanulate, 15 mm. in diameter at mouth, the limb 2 to 4 cm. broad, the lobes suborbicular, 12 to 15 mm. broad, undulate or erose; one filament of each pair of stamens 3 mm.

long, the other 8 mm., glabrous; anthers oblong, 4 mm. long, about 1 mm. broad, obtuse; style 20 mm. long, glabrous, the developed lobe of the stigma 2 mm. long, 1 mm. broad; capsule cylindric, 17 to 20 mm. long, 3 mm. broad, acute at apex, the callus puberulent, otherwise glabrous; retinacula curved, 1.25 mm. long, truncate at apex; seeds numerous (usually 20 or more in each capsule), lenticular, 2 to 2.5 mm. in diameter, appearing glabrous when dry, mucilaginous-pilose when moist

TYPE LOCALITY: Jamaica

Specimens examined.[2]

FLORIDA: Without locality, *Rugel* 742

CUBA: Columbia, *Curtiss* 730 Nuevitas, Camaguey, *Shafer* 1129. Without locality, *Wright* 1353

JAMAICA: Port Antonio, on rocks of old Spanish fort, *Harshberger* 99. Hope Gardens, Kingston, dry ground, *Maxon* 1630. Between Kingston and Gregory Park, *Maxon & Killip* 302. Mouth of Great River, west of Montego Bay, *Maxon & Killip* 1432a.

HAITI: Miragoane, *Eyerdam* 31. Without locality, *Jaeger* 130. Port au Prince, *Leonard* 2765, 2785. Étroite, Gonave Island, open woods, *Leonard* 3372 Étang, Étang Saumatre, clearings, *Leonard* 3566.

DOMINICAN REPUBLIC: Haina, roadsides and open fields, *Faris* 183 Barahona, *Fuertes* 221. Azua, *Rose, Fitch & Russell* 3692. San Pedro de Macorís, *Rose, Fitch & Russell* 4179. Without locality, *Wright, Parry & Brummel* 362.

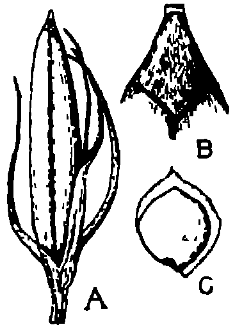

FIG 1 *Ruellia tuberosa.* A capsule, × 2, B tip of capsule, × 10, C. seed, × 10.

PORTO RICO: Guayanilla, roadside, *Britton & Shafer* 1797. Fajardo, *Heller & Heller* 988. Yauco, *Heller* 6295. Ponce, *Prey* 8. Isabel Segunda, rocky hillsides, *Shafer* 2434 Salinas de Cabo Rojo, *Sintenis* 618. San Juan to Cangrejos, *Sintenis* 618b Fajardo, *Sintenis* 1619. Guanica, *Sintenis* 3386. Guayama to Aguirre, brackish marsh, *Underwood & Griggs* 377.

ST. THOMAS: Raccoon Bay, *Britton, Britton & Shafer* 161.

ST CROIX: Bassin Yard, *Ricksecker* 259

ST. JAN: Lamosure, rocky hill, *Britton & Shafer* 617.

MONTSERRAT: Without locality, *Shafer* 502.

GUADELOUPE: Without locality, *Duss* 2366

BARBADOS: Bathsheba, dry hillside, *Miller* 80. Without locality, *Botanic Station Herbarium* 74.

TRINIDAD: *Botanic Gardens Herbarium* 2914.

COLOMBIA: Estrella, Caño Papayal, Lands of Loba, Dept. Bolívar, common along roadsides, *Curran* in 1916. Cartagena, *Heriberto* 100. Dept. Atlántico, *Pennell* 12047 Santa Marta, *Smith* 746. Mariquita, Magdalena, *Triana* in 1852. Río Frío, Santa Marta, *Walker* 1205.

CURAÇAO: Sint. Jaris, *Curran & Haman* 237.

VENEZUELA: Ciudad Bolívar, *L H. & E. Z. Bailey* 1621. Cristóbal Colón, *Broadway* 134. Río Chico, Miranda, *Jahn* 1245. El Vallé,

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[2] All specimens cited are in the U S National Herbarium.

Miller & Johnston 88. Perijá, State of Zulia, *Tejera* 177. La Trindad de Maracay, *Pittier* 5774. Between San José and Río Chico, State of Miranda, *Pittier* 6356 Hacienda El Volcán, near Santa Lucía, *Pittier* 8249. El Palito, near Puerto Cabello, in cactus formation, *Pittier* 9085. Valera and vicinity, Trujillo, *Pittier* 10786.

BRITISH GUIANA: Without locality, *Jenman* 4801. Peter's Hall and vicinity, Georgetown, weed in field, *Hitchcock* 16681. Georgetown, *Warren* in 1924.

The most striking characteristics differentiating the three allied species, *R. tuberosa*, *R intermedia*, and *R. nudiflora* are found in the capsules. In *R. tuberosa* these are noticeably slender and cylindric, and, except for narrow cuneate puberulent calluses at the tip, are entirely glabrous, whereas the capsules of *R. nudiflora* are shorter, broader, more abruptly narrowed to the solid stipelike basal portion, and strongly puberulent; the hairs, at least on the lower portions, retrorse. The seeds of *R tuberosa* are smaller and more numerous, and the flowers are broader and seem to be deeper lavender.

Between *R tuberosa* and *R. intermedia* the difference is not so great In habit and leaf characters the two species seem identical, but the capsules and seeds of *R. intermedia* agree in size and shape with those of *R. nudiflora.*

The geographical distribution of these three species is likewise highly significant. From the United States true *R. tuberosa* is represented in the National Herbarium by a single specimen collected in Florida. In Cuba, Hispaniola, Porto Rico, and Jamaica southward throughout the West Indies and northern South America it is rather common. On the other hand, *R nudiflora* with its varieties is confined to Texas, southern New Mexico and Arizona, Mexico, and northern Central America.

Linnaeus described *R. tuberosa* as having "foliis ovatis crenatis, pedunculis unifloris." This would indicate that he had a one-flowered specimen, which is relatively rare in this species.

Nees's description of *Cryphiacanthus barbadensis* agrees with true *R tuberosa*, but the range given includes the regions producing both *R intermedia* and *R. nudiflora*, with varieties. Some of the varieties of *R. nudiflora* described in the present paper correspond to the varieties accompanying that description. Later writers, except Lindau, describe *R. tuberosa* as having puberulent capsules and the wide range here stated. The type locality of *C. barbadensis* and *R. clandestina* is Barbados, an island well within the range of true *R. tuberosa.*

As is frequently the case with plants of a showy or ornamental nature, a number of common names have been given to *R tuberosa*. Some of these are "ipeca bâtard" or "petit ipica chandelier" (Guadeloupe), "many roots," "estilladora" (Porto Rico), "patale macaque" (Martinique), "salta perico" (Cuba), "minie root" (Barbados), "fleurs pétards" (Haiti).

2. **Ruellia intermedia** Leonard, sp. nov.

Roots thick-fibrous; stems 5 to 40 cm. high, erect or ascending, branched, quadrangular, puberulent, with additional spreading hairs about 1 mm. long; petioles 5 to 20 mm. long, channeled, puberulent, with a few longer spreading hairs; leaf blades ovate to suborbicular, obtuse or rounded at apex, rounded or narrowed and decurrent at base, 2 to 7 cm. long, 1.5 to 4 cm. broad (those of the axillary shoots much smaller), thin, entire or undulate, both surfaces more or less puberulent, especially along the midrib and veins, sometimes with a few additional spreading hairs, the cystoliths prominent, up to 0.25 mm. long; flowers solitary or several in axillary dichotomous cymes, with a flower in the forks; peduncles up to 10 cm. long (usually not exceeding 4 cm.), puberulent; bracts lanceolate or oblanceolate, 3 to 15 mm long, 1 to 3 mm broad; pedicels stout, 3 to 8 mm long, puberulent, calyx 10 to 22 mm. long, puberulent, the short hairs often mixed with longer spreading ones, usually glandular, the tube 1 to 2 mm. long, the segments linear, about 1 mm. broad at base, acute at tip, sometimes spreading at maturity, corolla 4 to 6 cm. long, purple, puberulent, the tube 2.5 mm long, 2 to 3 mm. in diameter, the throat funnelform, slightly oblique, 1 to 1.5 cm. broad at mouth, the limb 2 to 4 cm. broad, the lobes ovate, 10 to 15 mm long, 10 to 14 mm. broad, undulate, one filament of each pair of stamens 6 mm. long, the other 12 mm, glabrous; anthers oblong, 3.5 mm long, 1 to 1.5 mm broad; ovary glabrous, with a tuft of hairs at the tip, style 3 to 3.5 cm long, sparingly and minutely pilose, the developed lobe of the stigma 2.5 mm. long, 0.5 mm broad; capsule 18 mm. long, 4 to 5 mm broad, bluntly pointed at apex, gradually narrowed to a solid stipitate base about 2 mm. long, glabrous except for the pilose cuneate calluses near the tip, 10 to 12-seeded; retinacula truncate at apex, seeds lenticular, 2 to 2.5 mm in diameter, mucilaginous-pilose when moist

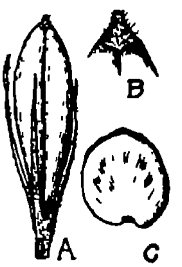

Fig 2 *Ruellia intermedia* A capsule, × 2, B tip of capsule, × 10, C. seed, × 10

Type in the U. S. National Herbarium, no 301,864, collected at Bolaños, Jalisco, Mexico, September, 1897, by J. N. Rose (no 2915).

Additional specimens examined:

SINALOA: Imala, *Palmer* 1415. Las Palmas, *Ortega* 4516. Without locality, *Ortega* 4222 Hacienda Oso, Culiacán, *Partida* 2009. Rosario, *Rose* 1849 Mazatlán, thickets, *Rose, Standley & Russell* 14072

COLIMA: Colima, *Palmer* 41

MICHOACÁN or GUERRERO: Chutla, *Langlassé* 260.

MORELOS: Yautepec, *Rose, Painter & Rose* 8602

GUERRERO· Iguala, altitude about 1,000 meters, *Rusby* 15.

This species is intermediate between *R. nudiflora* and *R. tuberosa*. It differs from the former in the shorter rounded leaves and glabrous capsules and from the latter in the puberulent stems and broader fewer-seeded capsules. The specimens cited vary somewhat in the proportion of glandular hairs and in the size of the flowers *Rose, Standley & Russell* 14072 is a stunted plant, only a few centimeters high.

In Sinaloa the native name is given as "hierba del toro"

3. RUELLIA NUDIFLORA (Engelm. & Gray) Urban, Symb. Antill. 7: 382. 1912.

Dipteracanthus nudiflorus Engelm. & Gray, Bost. Journ. Nat. Hist. 5: 229. 1845.

Cryphiacanthus viscosus Oerst. Nat For. Kjöbenhavn Vid. Medd. 1854: 128 1854. Not. *R. viscosa* H B. K

Roots clustered, thick-fibrous; stems erect or ascending, 5 to 30 cm. high, usually branched, obscurely quadrangular, puberulent, with occasional longer spreading hairs, or glabrate; petioles 0.5 to 4 cm. long, both puberulent and pilose; leaf blades ovate or oblong, 2 to 12 cm. long, 1.5 to 7 cm. broad, obtuse at apex, narrowed or rarely rounded at base, decurrent, thickish, undulate-crisped, sparingly puberulent or pilosulous, sometimes glabrate; inflorescence a terminal panicle of erect or ascending dichotomous cymes with a pediceled flower in each fork, or, when the peduncles are very short, an interrupted spike of verticillasters, or occasionally a single verticillastrate head; peduncles up to 5 cm. long but usually much shorter, puberulent, more or less glandular; bracts linear, 3 to 10 mm. long; pedicels 3 to 5 mm. long, glandular-puberulent; calyx 12 to 18 mm. long, glandular-puberulent, the tube very short, the segments linear or subulate; corolla purple, finely pubescent, 3 to 6 cm. long, the tube slender, 1 to 3 cm. long, 1 to 2 mm. in diameter, the throat funnelform or narrowly campanulate, 1 to 1.5 cm. broad at mouth, the limb 1.5 to 3 5 cm. broad, the lobes suborbicular, 10 to 15 mm. in diameter, erose; one filament of each pair of stamens 9 mm. long, the other 11 mm., glabrous; anthers 4 5 mm long, about 1 mm. broad; ovary puberulent; style 3 5 cm. long sparsely pilosulous; the developed lobe of the stigma 2 mm. long, 0 5 mm. broad; capsule 15 mm long, 4 mm. broad, pointed at tip, short-stipitate at base, puberulent, 8 to 16-seeded; retinacula curved, about 2 mm. long, truncate at apex, seeds lenticular, 3.5 mm. long, 3, mm. broad, mucilaginous-pilose when moist.

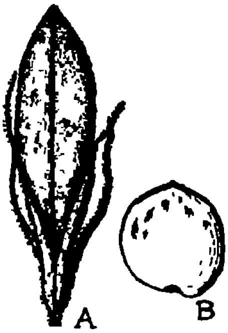

Fig. 3 *Ruellia nudiflora*. A. capsule, × 2, B. seed, × 10

TYPE LOCALITY: Open woods at Sim's Bayou near Houston, Texas. Type collected by Lindheimer.

Specimens examined:

ARIZONA: Picture Rocks, Tucson Mts, *Bartram* 396. Santa Cruz Valley near Tucson, *Pringle* in 1881

TEXAS: San Antonio, dry meadows, *Ball* 904; with white flowers, 905. Bryan, Brazos Co, low ground, *Biltmore Herbarium* 11080a. Travis Co, moist prairies, *Bodin* 214. Colombia, Brazoria Co., prairie, *Bush* 147, 313 Río Hondo, Cameron Co., *Chandler* 7053. Sequin, *Earle* 431. Houston, *Fisher* 92 San Antonio, white flowers, *Fisher* 103. La Porte, Harris Co., *Fisher* 628. Bracken, Comal Co., sandy soil, *Groth* 134. Hempstead, Walker Co, prairies, *Hall* 426. Houston, wet soil, *Hall* 427. San Antonio, *Havard* in 1881 (?). Corpus Christi, *Heller* 1417. Without locality, *Hildebrandt*. Burnet Co., *Hill* 18. Comanche Spring, Pecos Co, *Lindheimer* 1066. Bexar Co, *Jermy* 59. Without locality, wet places, *Mackenzie* 38. Santa Maria, Cameron Co., *Nealley* 170. Without locality, *Nealley* 86a, 301. Brownwood, Brown Co, rich prairies, flowers white, *Reverchon* 724. Blanco Co., flowers white, *Reverchon* 724. Corsicana, Navarro Co., *Reverchon* 3213. Dallas, low rich lands, *Reverchon* (*Curtiss* 1945). Rio Cibolo, in mesquite woods, *Ridell* in 1839. Tarrant Co., dry woods along the Trinity River, *Ruth* 546. Bexar Co., *Schulz* 740. Austin, escape from cultivation, *Schulz* 743. San Antonio, *Slater* in 1918. Brownsville, Cameron Co., *Townsend* 28. Pierce, Wharton Co., *Tracy* 7642. Kingsville, *Tracy* 9183. Tom Green

Co., *Tweedy* 2. Houston, *Ward* in 1877. El Paso, *Wright* 431. Spofford, Kinney Co., *Wooton* 126 Industry, Austin Co , *Wurzlow* 33.

TAMAULIPAS: San Fernando to Jiménez, *Nelson* 6605 Vicinity of Tampico, *Palmer* 436. Buena Vista, *Wooton* in 1919.

NUEVO LEÓN: Monterrey, Bella Vista, *Arsène* 6184 (*Bro. Abbon* 6).

COAHUILA: Sabinas, *Nelson* 6760. Saltillo, *Palmer* 159.

SINALOA: Las Mochis, *Tays* in 1912

DURANGO: Durango, *Palmer* 650

OAXACA: Guatulco, *Liebmann* in 1842 (type coll. of *Cryphiacanthus viscosus* Oerst)

The present species is usually distributed as *R tuberosa.* It differs constantly from that in the narrower and more slender corolla and thicker and usually shorter puberulent capsules with fewer seeds

The vernacular names "tremadora" and "violeta" have been given to this plant in Mexico Tays states that in Sinaloa it is used as a cure for snake bites.

This species is extremely variable in habit, in size and shape of flowers and leaves, and in the nature of the pubescence. These variations are sufficiently constant to permit the maintenance of several varieties.

KEY TO R. NUDIFLORA AND ITS VARIETIES

- Leaves puberulent (often grayish).
  - Plants erect; at least a part of the inflorescence a naked terminal panicle; corolla 4 to 6 cm long.
    - Leaf blades broadly ovate . . . . 3a. var. *occidentalis.*
    - Leaf blades oblong. 3b. var *grandiflora.*
  - Plants low, spreading or ascending; inflorescence of axillary cymes. 3c var. *puberula.*
- Leaves glabrous or pilosulous (usually sparsely so).
  - Plants low, seldom over 10 cm. high, few-flowered; stems strongly pilosulous . . . . . . 3d var. *humilis.*
  - Plants tall, usually over 20 cm. high; flowers several or numerous; stems puberulent, sparingly pilosulous, or glabrate
    - Inflorescence verticillastrate; bractlets crowded, peduncles elongate. (The inflorescence of *R nudiflora* and of the varieties *ovata* and *occidentalis* is often more or less verticillastrate, but when so, the pedicels are very short.). . . . 3e. var *congesta.*
    - Inflorescence of peduncled dichotomous cymes, some, at least, of these forming a naked terminal panicle.
      - Leaves mainly basal; plants usually less than 30 cm. tall, inflorescences beginning at the base of the plant . . 3f. var *yucatana.*
      - Leaves distributed on the stems; plants usually over 30 cm tall, inflorescence more or less terminal.
        - Leaves prevailingly large, at least some of them over 5 cm broad; inflorescences densely glandular-pilosulous 3g. var. *glabrata.*
        - Leaves smaller, seldom over 4 cm. broad; inflorescences glandular-puberulent.
          - Corolla 2 to 3 cm. long, the tube 7 to 10 mm. long, the panicle large, open (plants of West Indies) 3h var *insularis.*
          - Corolla 3 to 6 cm. long, the tube usually over 10 mm long; panicles usually narrow (mainland plants). . . . . . . 3. *R. nudiflora.*

3a. Ruellia nudiflora occidentalis (A. Gray) Leonard.

Ruellia tuberosa occidentalis A. Gray, Syn. Fl. 2^1: 325. 1878 (in part).

Plants larger than in the species, up to 60 cm. high; stems erect or ascending, branched, glandular-pubescent; petioles slender, 1 to 4.5 cm. long, glandular-pubescent, leaf blades ovate, 4 to 18 cm. long, 2.5 to 8 cm. broad, obtuse or rounded at apex, rounded or subcordate and decurrent at base, undulate or crenate, grayish-puberulent, more or less glandular; inflorescence a large terminal panicle, or an interrupted spike of verticillasters, the branches glandular-puberulent, the bracts linear, 5 to 10 mm. long, glandular-puberulent; peduncles up to 3 mm. long; calyx 1 5 to 2 5 cm. long, densely glandular-pilosulous, the segments linear-subulate; corolla purple, 4 to 5 cm. long, the tube 2 to 3 cm long, 2 mm in diameter, the throat funnelform, 15 mm broad at mouth, the limb 2 to 3 cm broad, one filament of each pair of stamens 10 mm long, the other 14 mm., anthers 3 mm long, 1 mm. broad; style 4 cm long, developed lobe of the stigma 2 mm. long, scarcely broader than the style; capsule 15 to 17 mm. long, puberulent, some of the hairs glandular

TYPE LOCALITY: Texas. Type collected by Berlandier.

Specimens examined:

"NEW MEXICO". Without locality, *Wright* 1455.

TEXAS: Sabinal Canyon, shaded rocks, *Revershon 1579.* Atascosa Co., sandy soil, *Schulz* 489c. El Paso, *Wright* 430.

NUEVO LEÓN: Monterrey, Guadalupe, alt 540 meters, *Arsène* 6143 (*Abbon* 25). Monterrey, along an irrigation ditch, *Dodge* 75

VERACRUZ: Río de Santa María, Zacualpan, rocky open woods, *Purpus* 1940, 2264 Barranca de la Ternera, *Purpus* 8205.

OAXACA: Cuicatlán, *Conzatti* 3989.

This variety is based on the large cordate ovate leaves, large viscid panicles, and slender corollas.

3b **Ruellia nudiflora grandiflora** Leonard, var. nov.

Stem erect or ascending, puberulent with interspersed longer spreading hairs, more or less glandular above; petioles up to 1 cm long, puberulent with minute curved hairs and sparsely pilose; leaf blades oblong, 3 to 6 cm long, 1 to 2 5 cm broad, strongly crenate-crisped to subentire, obtuse or acutish at apex, narrowed and decurrent at base, puberulent and pilosulous; flowers in 3's, subsessile on short ascending peduncles (up to 3 cm. long), or verticillastrate; calyx 15 to 22 mm. long, pilosulous, more or less glandular, the segments subulate, 1 mm. broad at base; corolla 6 cm. long, the tube slender, 2 to 3 cm. long, 2 5 to 3 mm. in diameter, the throat funnelform, 15 mm. broad at mouth, the limb 3 to 4 cm. broad, the lobes 15 to 17 mm. broad, undulate; one filament of each pair of stamens 12 mm. long, the other 15 mm.; anthers 4.5 mm long, 1.5 mm. broad; ovary puberulent; style 4 to 5 cm. long; mature capsule not seen.

Type in the U. S. National Herbarium, no 452,096, collected near Yautepec, Morelos, Mexico, July, 1905, by J. N. Rose, J. H Painter, and J. S. Rose (no 8601)

Additional specimen examined:

DURANGO: Ramos to Inde, *Nelson* 4691.

Nelson 4691 from Durango, is apparently eglandular, but in all other respects it agrees with the type.

3c. **Ruellia nudiflora puberula** Leonard, var. nov.

Low spreading plants 10 to 20 cm. high, stems ascending, branched, puberulent, the minute hairs mixed with longer spreading ones, the younger stems rather densely pilose; petioles about 1 cm. long, leaf blades oblong-elliptic, 2 to 10 cm long, 1 to 3 cm. broad, obtuse or rounded at apex, gradually narrowed and decurrent at base, firm, undulate-crisped, gray-puberulent with minute curved hairs interspersed with longer spreading ones; inflorescence of axillary dichotomous cymes with a flower in the forks, peduncles 1 to 9 cm. long, glandular-pubescent; bracts leaf-like, 5 to 10 mm. long, 2 to 3 mm broad, occasionally much larger; pedicels 5 to 10 mm. long or the one in the lowest fork becoming stout, and 15 to 20 mm long, calyx 15 to 30 mm. long, grayish-puberulent and ciliate, the segments linear, keeled, 1 mm. broad at base; corolla 3 to 4 cm long, the tube 10 to 12 mm. long, 1 5 mm in diameter, abruptly enlarged into the broadly funnelform or narrow campanulate throat, this 15 mm. broad at mouth, the limb 3 to 3 5 cm. broad, the lobes rounded, undulate, often emarginate; one filament of each pair of stamens 5 mm. long, the other 9 mm., anthers 3 5 mm. long, 1 mm broad; style 2 to 2 5 mm. long, the developed lobe of the stigma 2 mm. long, 0.5 mm broad, capsule 15 to 18 mm. long, 4 mm. broad.

Type in the U S National Herbarium, no 579,619, collected in pasture near Gualan, Guatemala, June 17, 1909, by Charles C. Deam (no. 6318)

Additional specimens examined·

OAXACA: Tlacolula, alt. 1,600 meters, *Conzatti* 1454. Lagunas, alt. 250 meters, *Nelson* 2652. Tehuantepec, *Orcutt* 3322

GUATEMALA: Gualan, in pasture, flowers nearly white, *Deam* 6332. Fiscal, barren hilltop, *Deam* 6227

SALVADOR: Río del Molino, Dept. Santa Ana, *Calderón* 2184. Laguna de Olomega Dept. San Miguel, alt 75 meters, *Standley* 21051.

This variety differs from the species in its grayish, sparingly glandular pubescence, axillary inflorescences, and smaller flowers The leaves are broader and more rounded at the apex.

3d. **Ruellia nudiflora humilis** (Nees) Leonard.

Cryphiacanthus barbadensis humilis Nees in DC Prodr 11: 198 1847.

Low plants, 5 to 15 cm high, stems white-pilose, glandular-puberulent above; petioles about 1 cm. long, white-pilose, flowers 2 or 3, in dichotomous cymes, the peduncles densely glandular-puberulent; pedicels 2 to 5 mm. long; calyx 10 to 15 mm. long, the lobes subulate; corolla 3 to 4 cm long, the tube about 12 mm long, the throat funnelform, 10 to 12 mm. broad at mouth, the limb 2 to 2 5 cm broad, the lobes rounded, emarginate, one filament of each pair of stamens 5 mm. long, the other 8 mm.; anthers 2 5 mm. long, 1 mm. broad; style about 2 cm. long, the developed lobe of the stigma 2 mm. long, 0 5 mm. broad, capsule 12 to 13 mm long, 4 mm broad

TYPE LOCALITY: Cuba.

Specimens examined:

TEXAS: Bexar Co, *Jermy* 146 Fort Clark, Kinney Co., *Mearns* 1440.

This variety is distinguished by the short stems, small ovate pilose leaves, and short few-flowered cymes.

3e. **Ruellia nudiflora congesta** Leonard, var. nov.

Low plants; stem erect, 15 to 20 cm. high, branched, puberulent, the nodes pilose, glandular above; petioles 5 to 10 mm. long; leaf blades oblong, 4 to 8 cm. long, 1 to 3 cm. broad, rounded at apex, narrowed and decurrent at base, sparingly pilose, or the veins on the lower surface sparsely puberulent; inflorescence verticillastrate, the flowers in 3's, on peduncles 1 to 2 mm. long; bractlets lanceolate, 3 to 5 mm. long, 1 to 1 5 mm. broad, glandular-pilosulous, crowded at base of pedicels; pedicels 1 to 2 5 cm. long, glandular-pilosulous; calyx 12 to 13 mm. long, the tube 1 mm. long, the segments subulate, keeled, densely glandular-pilose, flowers not seen; capsules about 1 mm. long.

Type in the U S. National Herbarium, no. 938,568, collected in San Luis Potosí, Mexico, in 1877 by J. G. Schaffner (no. 398).

The verticillastrate inflorescence with crowded bracts and elongate pedicels is peculiar to this variety. In shape and arrangement of leaves it resembles the variety *yucatana*.

3f. **Ruellia nudiflora yucatana** Leonard, var. nov.

Roots thick-fibrous or fusiform, stem 5 to 30 cm high, usually branched, puberulent, the hairs short and curved, interspersed with longer spreading ones, glandular above; leaves mostly basal; petioles slender, up to 3 cm long; leaf blades oblong-elliptic or spatulate, 4 to 12 cm. long, 1 to 4 cm. broad, rounded at apex, gradually narrowed and decurrent at base, pilosulose or glabrate, the cystoliths prominent; inflorescences peduncled, glandular-puberulent, dichotomous cymes produced by the entire plant, the lower axillary, the upper forming a naked terminal panicle, the flowers in 3's, crowded at the tips of the branches; bracts linear, 5 mm. long; peduncles 1 to 3 mm. long, or that of the lowest flower occasionally reaching 15 mm.; calyx 5 to 14 mm. long, glandular-puberulent, the segments subulate, the tips usually curved or twisted; corolla 2 5 to 3 cm long, the tube 6 mm. long, the throat funnelform, 1 cm. broad at mouth, the limb 2 5 cm. broad, the lobes rounded, about 1 cm. broad; one filament of each pair of stamens 4 mm long, the other 6 mm.; anthers 2 5 mm. long, 1 mm broad; capsule 12 mm. long.

Type in the U S National Herbarium, no. 268,387, collected in open grounds near Izamal, Yucatán, in 1895, by G. F. Gaumer (no. 759).

Additional specimens examined:

YUCATÁN: Izamal, in open grounds, *Gaumer* 488. Chichankanab, *Gaumer* 1801. Without locality, *Gaumer* 24218. Mérida, waste ground, *Valdez* 23.

The small crowded flowers, the curved calyx segments, the spatulate basal leaves, and the presence of basal cymes characterize this variety.

3g. **Ruellia nudiflora glabrata** Leonard, var. nov.

Ruellia tuberosa occidentalis A. Gray, Syn. Fl. 2^1: 325. 1878 (in part).

Large plants; stem erect, branched, glabrous, sparsely pilose below, glandular-puberulent above, the cystoliths prominent, petioles 1 to 3 cm. long, glabrous or sparingly pilose, leaf blades ovate to oblong-ovate, 6 to 18 cm. long, 3 to 10 cm. broad, rounded or obtuse at apex, rounded, then narrowed and decurrent at base (narrowed basal portion relatively broader than in the variety *occidentalis*), undulate or crisped, glabrous or the veins sparingly pilose, the cystoliths prominent; inflorescence a terminal open panicle of dichotomous cymes with a flower in the forks, or, when the peduncles are very short, an interrupted spike of verticillasters, the branches of the inflorescence, the pedicels, and calyces glandular-pubescent; corolla purple, 2.5

to 4 cm. long, the tube 1 cm long, 2 mm in diameter, the throat funnel form, 1.5 cm. broad at mouth, the lobes rounded, 10 to 15 mm. broad, undulate or entire, the limb 2 to 3 cm. broad, one filament of each pair of stamens 6 mm. long the other 12 mm., anthers 3.5 to 4 mm. long, 1 mm. broad; style about 2 cm. long, sparingly puberulent, the developed lobe of the stigma 2 mm long 0.5 mm. broad, capsule 15 mm. long, 3 to 6 mm. broad.

Type in the U. S National Herbarium, no. 44,091, collected at Ciénaga, New Mexico, Aug. 1874, by J T Rothrock (no 560).

Additional specimens examined:

Arizona: San Bernardino Ranch, *Mearns* 737, 1999. Tumamoc Hill, Tucson, *Harris* C16551 Tucson, *Smart* in 1867, *Thornber* 55.

Tamaulipas: Tampico, alt 15 meters, *Palmer* 172.

Sonora: La Ciénaga, under mesquite, *Goodding* 959. Guaymas, *Palmer* 98.

Sinaloa: Topolobampo, *Palmer* 194. Fuerte, along a hedge near town, *Rose, Standley & Russell* 13563

Colima: Without locality, *Palmer* 1287.

Oaxaca: Cuicatlán, *Nelson* 1664.

Tabasco: Without locality, *Rovirosa* 530.

Guatemala: Gualan, low place in pasture, *Deam* 6317.

Ruellia tuberosa occidentalis A Gray, described as a plant with "leaves from glabrate to velvety-pubescent," includes both *R. nudiflora occidentalis* (Gray) Leonard and *R nudiflora glabrata* Leonard. As all the specimens cited belong strictly either to the glabrous type or to the velvety-pubescent type, with no intermediates, this character was chosen as a basis for separation, the name *occidentalis* being assigned to the latter.

3h. Ruellia nudiflora insularis Leonard, var nov

Ruellia nudiflora Urban, Symb Antill 7: 382. 1912, in part, as to specimens cited; not *Dipteracanthus nudiflorus* Engelm. & Gray.

Suffrutescent; stem up to 40 cm. high, branched, erect or ascending, glabrous or sparingly pilose, minutely glandular-puberulent above; petioles slender 1 to 1 5 cm. long; leaf blades ovate, 2 to 7 cm. long, 1.5 to 4 cm. broad, rounded at apex, abruptly narrowed and decurrent at base, undulate or crenate-crisped, glabrous of the veins of the lower surface sparingly-pilose, the cystoliths conspicuous, inflorescences dichotomous cymes with a flower in the forks, the lower axillary, the upper forming a large naked open panicle; peduncles, pedicels, and calyces minutely glandular-puberulent, bracts lance-linear; pedicels up to 1 cm. long, calyx 15 mm. long, the segments subulate, 1 mm. broad at base; corolla bright purple, 3 cm. long, the tube 1 cm. long, 2 mm. in diameter, the throat funnelform, about 12 mm. broad at mouth, the limb 2.5 cm. broad, the lobes suborbicular, about 1 cm. broad, shallowly emarginate; one filament of each pair of stamens 5 mm. long, the other 7 mm.; anthers 4 mm. long, 1 mm. broad; ovary puberulent; style about 2 cm long; capsule 16 to 18 mm. long, 4 mm. broad, puberulent.

Type in the U. S. National Herbarium, no. 944,027, collected at Las Pailas, Cuba, May, 1889, by Eggers (no. 5452).

Additional specimens examined:

Haiti: Fond Parisien, shore of Étang Saumatre, along irrigation ditch, *Leonard* 4158.

Dominican Republic: Guayubín, Provincia de Monte Cristi, alt. 100 meters, *Abbott* 986 Barahona, *Fuertes* 804.

Except for its shorter puberulent capsules and smaller flowers this variety bears a close resemblance to *R. tuberosa* L.

4. **Ruellia lorentziana** Griseb Abh Ges. Wiss. Goetting. **24**: 259. 1879.

Suffrutescent; stem erect, obscurely quadrangular, glandular-puberulent, the cystoliths prominent, about 0.25 mm. long; petioles 1 to 3 cm. long, glabrous or sparsely pilose, the cystoliths numerous; leaf blades ovate, up to 10 cm. long, 5.5 cm. broad, obtuse at apex, abruptly narrowed and decurrent at base, rather firm, crenulate-crisped, both surfaces glabrous or bearing a few scattered hairs about 1 mm. long, the cystoliths numerous and prominent; inflorescence a terminal interrupted narrow panicle, the branches 2 or 3-flowered; peduncles 1 to 5 cm. long, glandular-puberulent; bracts linear, 3-to 8 mm. long, glandular-puberulent, pedicels 1 to 2 mm. long, glandular-puberulent, calyx 10 to 12 mm. long, glandular-puberulent, the tube 2 mm. long, the segments linear-subulate, unequal, 0.5 mm. broad at base; flowers not seen, the corolla described as "glabra; tubo e basi angusta supra calycem curve dilatato lobis late rotundatis duplo longiori, antheris inclusis cordato-oblongis;" capsule 2 cm. long, 4 mm. broad, fusiform, abruptly narrowed and pointed at apex, narrowed at base, the solid portion about 4 mm. long, 1 mm broad at lowest point, 2 mm broad at beginning of cavity 12 to 16-seeded, glandular-puberulent, retinacula tridentate at apex; seed flat, ovate, subcordate at base, about 3 mm. long and 2 mm. broad, mucilaginous-pilose when moist.

Type Locality: Tucumán, Argentina.

Specimen examined: Argentina, Formosa, *Jorgensen* 2845.

This species is closest to *R. nudiflora glabrata* but can be distinguished by its narrow panicle of crowded flowers, densely glandular stems, inflorescence, and capsules, smaller keeled calyx segments and glabrous (?) corolla.

BOTANY.—*New plants from Central America.*—*X.*[1] PAUL C. STANDLEY, U. S. National Museum.

Most of the plants described below belong to the genus *Ardisia*, of the family Myrsinaceae, a group of shrubs or small trees with edible fruits and handsome, though small, flowers. The genus is abundantly represented in the mountains of Central America.

There is included also the description of a species of *Elaphrium* obtained many years ago in Nicaragua by the pioneer Central American collector, Oersted. Although somewhat out of place here, I have inserted the diagnoses of two strikingly distinct Mexican plants procured by Dr. Blas P. Reko, who has contributed to the National Herbarium material of so many rare Mexican species.

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[1] Published by permission of the Acting Secretary of the Smithsonian Institution. For the last preceding paper of this series see page 309 of this volume of the The Journal. Received October 31, 1927

Elaphrium Oerstedii Standl., sp. nov.

Branchlets very stout, 7–8 mm thick, densely leafy at the tips, covered below with the large scars of fallen leaves, ochraceous, densely and finely tomentose at apex but soon glabrate; leaves crowded at the tips of the branches, petiolate, the rachis and petiole together 12-15 cm. long, slender, copiously puberulent and short-pilose with fulvous hairs; internodes of the rachis 7–25 mm. long; leaflets 11-15, the terminal one sessile or petiolulate, the lateral ones sessile, oblong or lance-oblong, 4-6.5 cm. long, 1.3–2 2 cm. wide, abruptly short-acuminate, with narrow, entire, acute or obtuse tip, at base obtuse and unequal, thick, shallowly and closely crenate, densely ciliate, puberulent above along the nerves, elsewhere glabrate, beneath paler, sparsely puberulent or short-pilose along the elevated costa, elsewhere glabrous or nearly so, the lateral nerves about 15 on each side, divergent at a wide angle, slightly arcuate, distinct nearly to the margin; panicles large, many-flowered, much branched, equaling or shorter than the leaves, pedunculate, the branches stout, angulate, short-pilose and puberulent, the flowers short-pedicellate; fruit obovoid, oblique, glabrous, 1 5 cm long and 1 cm broad, narrowed to the obtuse base.

Type in the herbarium of the Botanical Museum, Copenhagen, collected in Nicaragua by Oersted. A specimen of the same collection is in the U S. National Herbarium.

The type is an unmounted specimen, labeled in Oersted's hand, "In Nicaragua legi. Ord" A second sheet, evidently of the same collection, has the locality written in the same hand, as "In insula Jamaica." No such plant is known from Jamaica, and it is fairly safe to assume that the plant is a Nicaraguan one.

Only a few species of *Elaphrium* are known from Central America, the genus being very poorly represented outside Mexico, except for the widely distributed *E. simaruba*. *Elaphrium Oerstedii* is clearly distinct from any of the species reported heretofore from Central America.

Ardisia Cutteri Standl, sp nov.

A small tree, the branches stout, terete, brownish, leaves oblanceolate, about 52 cm long and 15 cm. wide, rounded at apex, long-attenuate from near the apex nearly or quite to the base of the short broad petiole, entire, subcoriaceous, green above, glabrous, minutely punctate, beneath paler, sparsely and very minutely brown-lepidote, the costa stout and salient, the lateral nerves very numerous, slender, prominent, divergent at a wide angle, connected by the lax irregular reticulation of the ultimate nerves; inflorescence terminal, paniculate, about 17 cm. long and broad, tripinnate, the branches slender, brown-lepidote with minute appressed scales; flowers umbellate at the ends of the branches, the pedicels stout, 6-8 mm. long; sepals 5, nearly distinct, orbicular, 2 mm. long, minutely lepidote dorsally, not evidently punctate, the margins finely brown-ciliolate; fruit globose, 1 cm in diameter, densely and coarsely punctate.

Type in the U S. National Herbarium, no 1,254,989, collected in wet forest near Pejivalle, Province of Cartago, Costa Rica, altitude about 900 meters, February 7, 1926, by Paul C Standley and Juvenal Valerio (no 47122).

This handsome plant is well marked by its remarkably large leaves and fruits, and can scarcely be confused with any other *Ardisia* reported from Central America. The species is named for Mr. Victor M. Cutter, President of the United Fruit Company, as a slight acknowledgment of his hearty cooperation in furthering botanical exploration in Costa Rica.

Ardisia minor Standl., sp. nov.

A shrub or small tree 1.5-6 m. high, the branches terete, grayish or brownish, somewhat rugose, glabrous, densely leafy, with short internodes; petioles stout, 3-7 mm. long, shallowly sulcate on the upper surface, glabrous, often marginate to the base; leaf blades narrowly elliptic to oblong-elliptic, often broadest above the middle, 2.8-6.5 cm. long, 1-2.5 cm. wide, acute or short-acuminate, often rather abruptly so, the tip obtuse or rounded, at base acute or acutely cuneate and often decurrent, entire, thin, glabrous, above green, dull, the costa slightly impressed, the lateral nerves inconspicuous, beneath paler, the costa slender, prominent, the lateral nerves very slender, prominulous, ascending at an angle of about 50 degrees, connected by the lax reticulation of the ultimate nerves; young leaves coarsely brown-punctate; inflorescence terminal, usually shorter than the leaves, small, few-flowered, bipinnate, glabrous, the rachis usually 2 cm. long or shorter, bearing usually 3 or 4 few-flowered umbels; bracts caducous; pedicels stout, 2-5 mm. long; sepals 5, nearly distinct, dextrorsely convolute, rounded-ovate to orbicular, 1.5 mm. long, obtuse to broadly rounded, glabrous, crenulate, green with scarious whitish margins, punctate with few coarse red-brown dots; fruit globose, black, 6 mm. in diameter; style slender, 2-3 mm. long; endocarp 4-4.5 mm. in diameter, finely costate.

Type in the U. S. National Herbarium, no. 1,306,429, collected in wet forest on Cerros de Zurquí, northeast of San Isidro, Province of Heredia, Costa Rica, altitude about 2,200 meters, March 3, 1926, by Paul C. Standley and Juvenal Valerio (no. 50571). Here are referred the following collections:

COSTA RICA: Cerro de las Caricias, Prov. Heredia, alt. 2,000-2,400 meters, *Standley & Valerio* 52408. Yerba Buena, Prov. Heredia, alt. 2,000 m., *Standley & Valerio* 50134. Cerros de Zurquí, *Standley & Valerio* 50590, 50613. Santa María de Dota, alt. 1,500-1,800 m., *Standley* 41621; *Standley & Valerio* 43456, 43467. Quebradillas, north of El Copey, Prov. San José, alt. 1,800 m., *Standley* 43040. Laguna de la Chonta, northeast of Santa María de Dota, alt. 2,100 m., *Standley* 42306.

Ardisia minor belongs to the subgenus *Icacorea* and is closely related to *A. compressa* H. B. K. The latter is a widely distributed and highly variable species, but all its forms have larger leaves, an ampler, more branched inflorescence, and pale sepals.

Ardisia Maxonii Standl., sp. nov.

A slender shrub or small tree 3-5 m. high, the branches stout, terete, rimose, glabrous, densely leafy, with short internodes; petioles very stout and broad, 2-4 mm. long, glabrous, often marginate to the base; leaf blades oblong-obovate, sometimes broadly so, 4-7 cm. long, 1.5-3.3 cm. wide, very obtuse or rounded at apex, broadly obtuse to acute at base, entire, glabrous, green and dull above, beneath paler, often brownish, densely and very minutely brown-punctate, the costa stout, prominent, the lateral nerves slender, prominent, ascending, connected by the irregular lax reticulation of the ultimate nerves; inflorescence terminal, usually much exceeding the leaves, densely many-flowered, tripinnate, 8 cm. long and broad or smaller, the rachis glabrous, angulate, the flowers pale pink, chiefly subumbellate at the ends of the branches; bracts caducous, pedicels stout, 4–7 mm long; sepals 1.5–2 mm. long, united below, suborbicular, rounded at apex, dextrorsely convolute, glabrous, entire, densely punctate with large glands; corolla 6 mm long, the lobes oblong, obtuse, nearly distinct, symmetric, glabrous, minutely and obscurely punctate, stamens equaling the corolla, the filaments very short, the anthers oblong, 3 mm. long, deeply cordate at base, glabrous, style very slender, 3 mm. long

Type in the U. S. National Herbarium, no 675771, collected in forest opening between the Río Ladrillo and Los Siguas Camp, southern slope of Cerro de la Horqueta, Chiriquí, Panama, altitude 1,200 to 1,700 meters, March, 1911, by William R Maxon (no. 5402). The following additional collections are at hand:

PANAMA: Humid forest around Los Siguas Camp, alt. 1,700 m , *Pittier* 3167. Camp Aguacatal, eastern slope of Chiriquí Volcano, alt. 2,100–2,200 m., *Pittier* 3117.

Ardisia Maxonii belongs to the subgenus *Icacorea* and is related to *A. irazuensis* Oerst., of Costa Rica. The latter has smaller flowers and pointed, often acute leaves

Pittier has recorded the vernacular name "uvilla" for *A Maxonii*

Ardisia pallidiflora Standl , sp. nov.

A shrub, the branches stout, terete, ochraceous, rimose, glabrous, the internodes about 1 cm long; petioles stout, 5-8 mm long, deeply sulcate on the upper surface, lepidote-furfuraceous with small appressed brown scales, leaf blades narrowly obovate-elliptic, 5.5-7 cm long, 2–3 cm. wide, abruptly acute to long-acuminate, with acute or obtuse tip, obtuse at base, entire, thick and firm, densely punctate with large glands, these most conspicuous on the young leaves, dull, the venation prominulous, beneath paler, sparsely lepidote with minute brown scales, the costa stout and prominent, the lateral nerves prominent, divaricate at a wide angle, connected by the lax reticulation of the ultimate nerves, inflorescence terminal, cymose, twice branched, lax, many-flowered, the flowers in umbels at the ends of the branches, the main rachis strongly zigzag, bearing at the base of each branch a leaflike brown-punctate petioled bract 1–1.5 cm. long; bracts at the base of the pedicel 1–2 mm long, persistent, linear, brown-punctate; pedicels slender, 10–13 mm. long, pale, sparsely and very minutely lepidote, often strongly curved, thickened at apex; sepals 1 5 mm long, rounded-ovate, very obtuse, glabrous, whitish, with scarious margins, bearing on the back a dense group of large brown-red glands, the margins minutely denticulate; flower buds 3.5 mm. long, acuminate; petals pale, ovate, acuminate, bearing a few large dark punctations; anthers shorter than the petals, lanceolate, 1 5 mm. long, long-acuminate.

Type in the U. S. National Herbarium, no. 677649, collected in humid forest between Alto de las Palmas and top of Cerro de la Horqueta, Chiriquí, Panama, altitude 2,100 to 2,265 meters, March 18, 1911, by H Pittier (no. 3255).

A member of the subgenus *Icacorea*, but easily recognized among the Central American species of that group by the pale cymiform inflorescence, the persistent bracts, and the long curved pedicels.

Ardisia tilaranensis Standl., sp. nov.

A slender shrub 1.5–3 m. high, the branchlets terete, when young densely furfuraceous with coarse brown appressed scales; leaves mostly sessile or nearly so, rarely on petioles 8 mm. long, the blades narrowly oblanceolate-oblong, 11–18.5 cm long, 3–5 cm. wide, acuminate or long-acuminate, narrowed to the base, this auriculate and often clasping, the auricles short and rounded, blades thin, sinuate-crenate, the upper surface green, dull, glabrous, beneath paler, rather densely lepidote with small, brown, closely appressed scales and conspicuously black-punctate, the costa slender, prominent, the lateral nerves very slender, numerous, divaricate at nearly a right angle, connected by the laxly reticulate ultimate nerves; inflorescence shorter than the leaves, twice pinnate, consisting of a few few-flowered umbels, the branches very slender, sparsely brown-lepidote, the panicle bearing at the bases of the primary branches 1 or 2 large green leaflike bracts, these 12–18 mm. long, ovate or lanceolate, sessile and clasping; pedicels about 5 mm. long; sepals 5, nearly distinct, broadly ovate or rounded-ovate, acute or obtuse, 1 mm. long, denticulate, glabrous, bearing numerous coarse blackish punctations; fruit globose, 6–7 mm. in diameter, purple-black, densely and coarsely black-punctate with elevated glands.

Type in the U. S. National Herbarium, no 1,254,496, collected in moist forest at Quebrada Serena, southeast of Tilarán, Guanacaste, Costa Rica, altitude about 700 meters, January 27, 1926, by Paul C. Standley and Juvenal Valerio (no 46169). The following collections from Guanacaste represent the same species.

COSTA RICA: Los Ayotes, alt 700 m., *Standley & Valerio* 45422. El Silencio, alt 750 m, *Standley & Valerio* 44729, 44763.

None of the specimens are in good condition, but they are uniform, and show clearly that the plant is distinct from all other Central American species of *Ardisia*. It is perhaps related to the Costa Rican *A. auriculata* Donn. Smith, of which I have seen no material, but that is a glabrous plant with entire leaves 40 cm. long

Ardisia Nevermannii Standl., sp. nov.

A slender shrub 1.5–2.5 m high, the branches terete, densely leafy at the tips, very densely hirsute with long stiff spreading ferruginous hairs; leaves sessile or nearly so, the petioles less than 5 mm long; leaf blades oblanceolate or oblanceolate-oblong, 16–29 cm. long, 5–8 cm wide, acuminate, long-attenuate to the base, there narrowly obtuse and subauriculate, entire, thin, deep green above and hirsute, much paler beneath, densely ferruginous-hirsute, conspicuously black-punctate, inflorescence terminal, pendent, the peduncle slender, 8–11 cm long, densely hirsute, the panicle lax, open, many-flowered, tripinnate, the primary branches long, slender, and curved, the flowers in umbels at the end of the branches, the panicles about 10 cm. long and broad; bracts persistent, those along the straight percurrent main rachis oblong or lanceolate, leaflike, 1–1.5 cm long, pedicels 5–8 mm. long, slender, hirsute; sepals 5, broadly ovate or oval, 1.5 mm. long sparsely hispidulous near the base, coarsely black-punctate, the margins pale and scarious, glandular-ciliolate; petals 4 mm. long, coherent at base, elliptic-ovate, acutish, glabrous, purple or purple-pink, densely and coarsely dark-punctate; stamens slightly shorter than the petals, the anthers lance-oblong, 2.5 mm. long, much exceeding the filaments; fruit globose, black, 7–8 mm. in diameter, the endocarp finely costate.

Type in the U. S. National Herbarium, no. 1,305,625, collected in wet forest at Finca Montecristo, on the Río Reventazón below El Cairo, Province of Limón, Costa Rica, altitude 25 meters, February 18, 1926, by Paul C. Standley and Juvenal Valerio (no. 48603). The following collections from the same vicinity represent this species:

Costa Rica: Finca Montecristo, *Standley & Valerio* 48484. Hamburg Finca, *Standley & Valerio* 48824, 48774, 48754.

Ardisia Nevermannii is a very distinct species, not obviously related to any other known from Central America. The hirsute pubescence alone is sufficient to distinguish it. The species is named for Mr. Ferdinand Nevermann, a keen student of Costa Rican Coleoptera, at whose home I was so fortunate as to be a guest while collecting about El Cairo.

Ardisia furfuracea Standl., sp. nov.

A small tree, the branches terete, very stout, very densely and coarsely furfuraceous with loose, dark brown scales, the internodes short; petioles very stout and broad, 1-2 cm. long but marginate nearly or quite to the base, deeply sulcate on the upper surface; leaf blades oblong or narrowly oblong, 17-27 cm. long, 4-7.5 cm. wide, acute at base and apex, entire, thick, green and glabrous above or sparsely lepidote along the shallowly sulcate costa, beneath brown, very densely lepidote-furfuraceous with coarse loose brown scales, rough to the touch, the costa salient, very thick and stout, the lateral nerves very slender, prominulous, numerous, ascending at a wide angle; inflorescence terminal, paniculate, pyramidal, about 20 cm. long and broad, tripinnate, the branches very stout, densely brown-furfuraceous; bracts caducous; flowers sessile on the branches or in dense few-flowered sessile clusters, the pedicels, if any, 2-2.5 mm. thick and 1-1.5 mm. long; flower buds acute, about 4 mm. long; sepals dextrorsely convolute, orbicular, 2 mm. long, glabrous, densely and coarsely punctate, the margin minutely denticulate; petals coalescent at base, ovate-oval, narrowed to the obtuse apex, glabrous, coarsely dark-punctate; anthers oblong-ovate, 1.8 mm. long, glabrous, cordate at base, the filaments nearly equaling the anthers, the stamens slightly shorter than the petals.

Type in the U. S. National Herbarium, no. 1,306,786, collected in wet forest on Cerro de las Lajas, north of San Isidro, Province of Heredia, Costa Rica, altitude 2,300 meters, March 7, 1926, by Paul C. Standley and Juvenal Valerio (no. 51556).

Ardisia furfuracea evidently is related to *A. palmana* Donn. Smith, of the same region. The latter has a much more open inflorescence and lacks the coarse furfuraceous covering which is so conspicuous in the species here described.

The flowers of *A. furfuracea* are white with pinkish dots.

Parathesis aeruginosa Standl., sp. nov.

Branches stout, terete, the internodes 1-1.5 cm. long, densely stellate-tomentose with red-brown, rather coarse, sessile hairs; petioles stout, 3-9 mm. long, densely stellate-tomentose; leaf blades elliptic-oblong, broadest at or slightly above the middle, 12-16 cm. long, 4-5 cm. wide, abruptly short-acuminate, cuneately narrowed to the acute base, decurrent upon the petiole, obscurely undulate-crenate, membranaceous, deep green above, sparsely stellate-pubescent along the costa, elsewhere glabrous, beneath densely stellate-hispidulous with red-brown hairs, the costa prominent, the lateral nerves numerous, slender, divergent at a wide angle, subarcuate, irregularly and laxly anastomosing near the margin; inflorescence terminal, paniculate, pyramidal, about 13 cm. long and broad, tripinnate, lax, many-flowered, the branches densely ferruginous-tomentose with sessile stellate hairs, the bracts linear, 2-3 mm. long; pedicels 2-4 mm. long, buds 3.5 mm. long; sepals nearly distinct, linear-triangular, 1.5 mm. long, stellate-hirtellous, acute; petals linear-oblong, 2 5 mm. long, minutely stellate-tomentose on both surfaces; stamens shorter than the petals, exserted in anthesis, the filaments very short, the anthers linear, 1.7 mm long, with a black dorsal line; ovary conic, glabrous, the style filiform, 2.5 mm. long, glabrous.

Type in the U S. National Herbarium, no 861823, collected in forests of Tremedal, near San Ramón, Costa Rica, altitude 1,300 to 1,400 meters, April 14, 1913, by A. Tonduz (no. 17659).

Obviously related to the Guatemala *P. sessilifolia* Donn Smith, which has similar pubescence but chiefly of stipitate, not sessile, hairs.

Maba nicaraguensis Standl , sp. nov.

Branchlets slender, subterete, ochraceous, densely furnished with pale, slightly elevated lenticels, the young branchlets densely fulvous-puberulent and short-pilose with spreading or ascending hairs; petioles stout, 4-6 mm. long, densely short-pilose, leaf blades chiefly obovate-oblong or oblanceolate-oblong, 3.5-7 cm long, 1-2.5 cm. wide, obtuse to rounded at apex, gradually narrowed to the acute to obtuse (rarely rounded) base, thick, deep green above, densely pilose, at least when young, with short slender spreading hairs, beneath scarcely paler, densely velutinous-pilose with short, stiff, grayish, mostly straight but partly curved hairs, the costa stout, prominent, the lateral nerves about 5 on each side, strongly ascending, obscurely anastomosing near the margin; pistillate flowers axillary, solitary, the stout pedicels 1-4 mm. long; calyx densely fulvous-tomentose on both surfaces, 3 to 5-lobate, 8-10 mm. long, the tube campanulate, the lobes broadly ovate, obtuse, thick, much longer than the tube, their margins slightly recurved; pistillate corolla urceolate, the tube 8 mm. long, 5 mm. broad, glabrous near the base, above (like the lobes) densely sericeous, the 4 lobes ovate, obtuse, 3 mm. long, erect, their margins incurved, the corolla glabrous within; ovary densely short-pilose, the style stout, 2.5 mm. long, sericeous.

Type in the U. S. National Herbarium, no. 1,266,111, collected near Managua, Nicaragua, April 16, 1926, by Diocleciano Chaves (no. 206).

Only one other species of *Maba* is known from Central America, *M. Veraecrucis* Standl , which has been collected in Salvador. It differs from *M. nicaraguensis* in having glabrate, usually acute or acuminate leaves.

In the Nicaraguan tree the calyx seems to be as often 4 or 5-parted as 3-

parted. In the genus *Maba* the calyx is supposed to be 3-parted; in *Diospyros* 4 or 5-parted. It is evident that in this case, at least, this difference does not hold, and it is therefore doubtful whether *Maba* can be maintained as a distinct genus.

Diospyros Rekoi Standl., sp. nov

Branchlets terete, blackish brown or dark reddish brown, bearing numerous small, pale, slightly elevated lenticels, the youngest branchlets very densely tomentose with short spreading fulvescent hairs, usually also pilose with a few longer hairs, the internodes short, subterete or compressed; petioles stout, 8–11 mm. long, densely tomentose; leaf blades variable, oval to oval-ovate, 10.5–15.5 cm. long, 6.5-7.8 cm. wide, broadly rounded to acute at apex, at base rounded to abruptly short-cuneate, thin, densely velutinous-hirtellous on the upper surface, beneath very densely pilose-tomentose with ochraceous, slender, stiff but more or less entangled hairs, the costa and lateral nerves prominent beneath, the costa stout, the lateral nerves about 9 on each side, ascending, irregular, pistillate flowers (staminate flowers not seen) axillary, the inflorescences sometimes 2-flowered, but the pedicels usually solitary, stout, straight or curved, densely tomentose, 8-18 mm. long; calyx green, densely tomentose on both surfaces, 5-lobate nearly to the base, in anthesis 1 5–2 cm. long, somewhat accrescent in age, the lobes somewhat unequal, oblong-ovate to lance-oblong, 7-8 mm wide, acute, abruptly short-acuminate, or narrowed to an obtuse apex, ovary ovoid-globose, 7 mm broad, densely pilose with short spreading hairs, the pubescence long-persistent, corolla globose-urceolate, glabrous within, densely tomentose outside, the tube 11 mm broad at base, 6-7 mm long, constricted above, the 5 lobes spreading, broadly ovate, obtuse, 4 mm. long; fruit depressed-globose, 4 5 mm. broad, glabrate.

Type in the U. S National Herbarium, no. 1,269,427, collected at Achotla, Guerrero, Mexico, altitude 700 meters, May, 1926, by Blas P. Reko (no. 4895). Called "zapote negro"

This is one of the most clearly distinct of all the Mexican species of *Diospyros* In the writer's key to the Mexican species[2] it runs at once to *D texana*, a tree with small leaves and fruit, to which it is not closely related. The dense pubescence of the leaves is the most conspicuous character of the plant.

Loeselia grandiflora Standl., sp. nov.

Plants perhaps suffrutescent, probably 60 cm. tall, much branched, the branches slender, stiff, the older ones with pale brown, exfoliating bark, the younger branches sparsely arachnoid-villous, at least about the nodes, the internodes mostly 3–5 cm long, leaves all opposite, sessile, lance-oblong to oblong-ovate, broadest at base, 3-4 8 cm long, 1-2 cm. wide, long-attenuate to the narrow subulate-tipped apex, shallowly cordate and clasping at base, stiff, pale green, finely serrate with close spinulose-tipped teeth, minutely glandular-puberulent on both surfaces, the venation prominent and coarsely reticulate; flowers forming a large open much-branched panicle, the pedicels mostly 3–12 mm long, sometimes longer, sparsely tomentulose and glandular-puberulent; bracts of the branchlets subulate, entire, appressed, those (2–6) at the base of the flower linear-lanceolate, 10–12 mm. long, dark purplish, glabrous, ciliate-serrulate, closely appressed to the calyx; calyx 6 mm. long, greenish, hyaline, glabrous, lobed nearly to the base, the lobes lanceolate, acute, entire; corolla tube very slender, 1 cm. long, finely villous outside, the lobes (including the claw) about 1.5 cm. long, glabrous or nearly so, linear-oblanceolate, cream-colored when dry, 2-3 mm. wide, glabrous or nearly so, obtuse at apex and entire or nearly so, the claws, very long and slender, purplish; filaments long-exserted, glabrous.

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[2] Contr. U. S Nat Herb 23: 1126 1924.

Type in the U. S. National Herbarium, no. 1,269,768, collected at Achotla, Guerrero, Mexico, altitude 700 meters, January, 1927, by Blas P. Reko (no. 5100). No. 5057, from the same locality, is conspecific.

It is a surprise to come upon a new Mexican plant so strongly marked as this one. It is true that collectors are still finding in Mexico numerous undescribed species of plants quite as distinct as any ever published, but the present plant is, after *Loeselia mexicana*, the most clearly differentiated species of its genus. In other species of *Loeselia* the leaves are all or chiefly alternate, while in *L grandiflora* they are uniformly opposite. The large flowers, which must make the plant a rather handsome one, also are distinctive, and the form of the inflorescence is not matched in any other species. *L. grandiflora* belongs to the section *Euloeselia* Peter.

SCIENTIFIC NOTES AND NEWS

PAUL C. STANDLEY, of the National Museum, sailed from New York November 26, to spend the winter in botanical field work in Honduras. This Republic is almost wholly unknown botanically, and its exploration is expected to yield rich results. The work is being undertaken in cooperation with the Arnold Arboretum and the United Fruit Company.

Professor A S. HITCHCOCK gave an address before the Botanical Society of Pennsylvania at Philadelphia, November 19, on *The morphology and classification of the grass family.*

The Petrologists' Club met at the Geophysical Laboratory on November 15. Dr. G. P. MERRILL of the National Museum discussed *The petrology of meteorites.*

The meeting of the Pick and Hammer Club at the Geological Survey on November 19 was devoted to an informal discussion of the *Application of geophysical methods to geological problems.* N. H. HECK, of the Coast and Geodetic Survey, reported on the action of the International Geodetic and Geophysical Union in appointing a committee on this subject, and spoke of the Coast Survey's own work. W. J. ROONEY described the cooperative study of electrical methods under way by the Department of Terrestrial Magnetism (Carnegie Institution) and the Michigan School of Mines. A C. SPENCER reported on President Mason's New York address on the electrical methods. F. L. HESS spoke on the work of the U. S. Bureau of Mines and the Colorado School of Mines. There was discussion by F.E. WRIGHT, O. H. GISH, L. B. TUCKERMAN, P. R. HEYL, and others.

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PHYSICS.—*A note on the change of compressibility with pressure.*[1]

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The compressibility of practically all substances decreases with increasing pressure. For most solids this decrease is a very small quantity because the compressibility itself is very small; indeed, the change in compressibility is so minute that it is only by the use of delicate experimental methods and of a large pressure-range (10,000 megabaryes[2] or more) that it can be measured. It is sometimes convenient to determine the mean compressibility over a given pressure-range and not convenient or practicable to measure the variation of compressibility with pressure. The object of this note is to call attention to the relation between compressibility and change of compressibility of crystalline substances of moderate or low compressibility, for the purpose of providing an estimate of the pressure-coefficient of compressibility when the compressibility only is known.

The results of available measurements are shown in Table 1. The second column gives the compressibilities of the substances listed in the first column, and in column 3 are the corresponding values of the change of compressibility with pressure.

The compressibility β, according to the usual custom, is defined as the relative change in the volume V per unit increase in pressure, P. That is,

$$\beta = -\frac{1}{V_0}\frac{dV}{dP}$$

in which V_0 is the volume at $P = 0$; and β_0 is the compressibility at

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[1] Received November 19, 1927.

[2] The megabarye (sometimes called the megabar) is the equivalent of 10^6 dynes per sq. cm. One megabarye = 0.987 atm.

zero pressure. In Table 1 the quantity, $-\Delta\beta$, means $-10^{10}\frac{d\beta}{dP}$, and is the decrease in the value of $10^{6}\beta$ for 10,000 megabaryes increase of pressure. For these substances of moderate compressibility $\frac{d\beta}{dP}$ is independent of pressure—at least within the error of experiment.

Two widely different methods have been used in obtaining compressibilities of solids. The one involves the measurement of the change of *length* of a specimen when subjected to pressure. This method is capable of great precision and is the one by which the larger part of the data in Table 1 was obtained. It has the disadvantage that the cubic compressibility can be obtained from a single series of measurements only when the substance belongs to the cubic system and is not aeolotropic from deformation or lack of homogeneity. The other method determines the volume-change and hence the cubic compressibility directly, and gives a true result for aeolotropic materials. Its disadvantage is its lesser sensitivity as compared with the linear method.

All of the available data for crystalline solids whose compressibility is $8\cdot10^{-6}$ or less are plotted on Figure 1, except tellurium, which does not fall in the diagram, and the alkali halides[9] which are known to be abnormal in many respects as compared with other compounds. The points for the alkali halides lie somewhat above the other points, forming, in a general way, a separate family of points. In the plot, measurements on cubic metals by the linear method are denoted by circles; direct measurements of cubic compressibility, or linear measurements in three directions on metals, by triangles; and measurements of all kinds on compounds, by crosses. Data for which different results were obtained with different samples (e.g. aluminum) are averaged to give a single point. Linear measurements with substances not belonging to the cubic system, on samples cut in one direction only, have not been included. It will be noted that in general $-\Delta\beta$ increases with β, that is, the greater the compressibility, the more it changes with increasing pressure. At first sight the points do not seem to fall any too well on a single curve, and yet the five or six points that are considerably off the curve probably attract the attention unduly as compared with the thirty or more points that do lie on or near the curve.

It is not the purpose of the writer to urge that $\Delta\beta$ is a single-valued function of β for all solids. In all probability $\Delta\beta$ depends on other

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[9] Slater, Phys. Rev. 23: 488. 1924.

TABLE I.—COMPRESSIBILITY AND CHANGE OF COMPRESSIBILITY WITH PRESSURE FOR VARIOUS SOLIDS THE UNIT OF PRESSURE IS THE MEGABARYE

MATERIAL	COMPRESSIBILITY $10^6\beta$	CHANGE OF COMPRESSIBILITY $-\Delta\beta$	REFERENCE
Iron	0 60	0 04	8
Platinum (wire)	0 37	0 04	8
Platinum (rod)	0 31	0 00	8
Molybdenum	0 36	0 02	8
Tantalum	0 49	0 01	8
Tungsten.	0 32	0 03	4,8
Palladium	0 53	0 04	8
Nickel	0 54	0 04	8
Cobalt	0 55	0 04	8
Gold	0 59	0 05	8
Copper	0 74	0 06	8
Uranium	0 99	0 05	8
Silver	1 01	0 09	8
Aluminum (rod)	1 39	0 07	8
Aluminum (casting)	1 37	0 10	8
Germanium	1 41	0 14	8
Lead	2 39	0 31	3,8
Cerium	3 65	0 40	8
Calcium	5 84	1 00	8
Strontium	8 35	1 51	8
Zinc	1 73	0 27	3,8
Bismuth	2 99	0 47	3,4
Antimony	2 75	0 65	4
Tin	1 90	0 28	3,4
Rhodium	0 38	0 56	5
Iridium	0 27	0 03	5
Cadmium	2 24	0 50	3
Quartz	2 70	0 44	3,7
Mica	2 34	0 40	6
Oligoclase	1 74	0 21	6
Microcline	1 92	0 29	6
Magnetite	0 55	0 04	7
Pyrite	0 70	0 04	7
Fluorite	1 23	0 13	7
Calcite	1 36	0 08	7
Celestite	1 59	0 16	7
Galena	1 91	0 13	7
Sphalerite	1 30	0 04	7

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[3] Adams, Williamson, and Johnston, Journ. Am Chem Soc 41: 12 1919

[4] Bridgman, Proc Am. Acad. Arts Sci. 60: 305. 1925

[5] Bridgman, Proc. Am Acad Arts Sci. 59: 109 1924

[6] Adams and Williamson, Journ Frank. Inst 195: 475. 1923

[7] Bridgman, Am Journ Sci. 10: 483. 1925

[8] Bridgman, Proc Am Acad. Arts Sci. 58: 165. 1923.

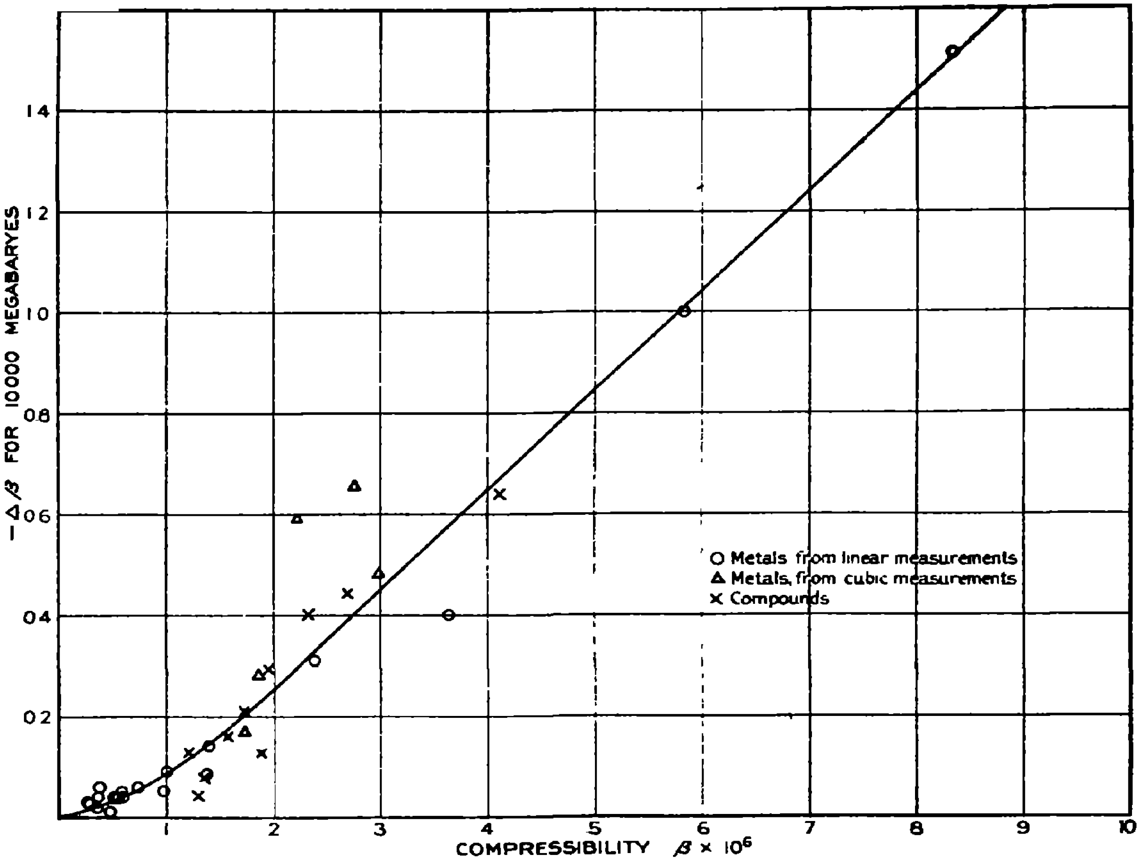

Figure 1.—The compressibility, $10^6\beta$, is plotted against $-\Delta\beta$, which is the decrease in $10^6\beta$ caused by 10,000 megabaryes increase of pressure The deviation of most of the points from the curve is hardly greater than the experimental error.

factors, but the divergence of the points in Figure 1, is for the majority of the materials, hardly larger than the error of experiment—experimental error caused perhaps more by a lack of compactness in the material than by the direct errors of observation. This effect in crystalline aggregates is well illustrated by the behavior of marble. Ordinary marble may show, under pressure, a perfect volume-elasticity, yet at low pressures the compressibility is abnormally high and falls more rapidly than can be accounted for by the elastic properties of the calcite grains themselves.

It is believed that the curve in Figure 1 will be of practical value in providing a rough estimate of the change of compressibility in substances for which the mean compressibility only, over a given pressure range, is known. For example, if the mean cubic compressibility of a material over the pressure range from 0 to 10,000 megabaryes were found to be 1.10×10^{-6}, then from the value of $\Delta\beta$ given by the curve it would follow that $10^6\beta$ would be 1.16 at zero pressure and 1.04 at $P = 10{,}000$. It is probable that these estimated values would not be in error by as much as ± 0.02.

A solution of the problem of the change of compressibility with pressure must await a more complete knowledge of the dynamics of the atomic aggregates in crystals. The problem must be attacked from the theoretical side as well as the experimental, and until more is known of interatomic forces as a function of distance, any prediction as to $\Delta\beta$ for a substance, if the mean compressibility only is known, must be made by some empirical method For solids of moderate compressibility (excluding the alkali metals and alkali halides) the curve given in the figure will provide an estimate of the change of compressibility accurate enough for many purposes

SUMMARY

The change of compressibility with pressure for crystalline solids is to a rough approximation dependent on the compressibility itself, the two quantities increasing together. The mutual relation is more obvious if the halides of the heavier alkalis be excluded; 85 per cent of the remaining observations deviate from a single smooth curve by an amount which is hardly greater than the experimental error. Hence this curve may be used to determine the order of magnitude, at least, of the pressure-coefficient of compressibility, if the mean compressibility over a given pressure-range is known.

MINERALOGY.—*Almandite-spessartite garnet from Gwynns Falls, Baltimore.*[1] EARL V. SHANNON and FOREST A. GONYER.

Pegmatite in the gneiss which is quarried at Gwynns Falls, Baltimore, bears garnet as scattered and fairly large crystals in a fairly coarse pegmatite, and as small crystals distributed in parallel lines in finer-grained pegmatite. The garnet of the latter rock, which presents a marked similarity to the banded garnetiferous rock in some of the gem-bearing pegmatites of the Southern California tourmaline field, was analyzed in the laboratory of the National Museum and the results are presented herewith.

The specimen from which the analyzed material came consists principally of quartz and feldspar in granular gneissic bands with some schistose mica partings. The feldspar is principally white to pale buff orthoclase and forms grains up to 1 centimeter across. The garnet is aggregated into granular, parallel and somewhat wavy bands from 1 to 3 millimeters wide which follow the general parallel structure of the rock. These bands consist of imperfectly euhedral crystals averaging 0.5 millimeter but reaching an extreme size of 2.0 millimeters and isolated in quartz and feldspar. The color ranges, according to size, from pale brownish pink to dark brownish red.

Garnet-rich pieces were crushed and screened between 40 and 100 mesh sieves, and the minerals separated with methylene iodide heavy solution. The cleaned sample consisted principally of euhedral garnet crystals formed by an equal development of the faces of the trapezohedron and the rhombic dodecahedron. The final sample showed only a very small number of extraneous grains, principally of adhering quartz, and when ground for analysis was homogeneously isotropic. The analysis gave the following results:

ANALYSIS AND RATIOS OF GARNET FROM BALTIMORE

(Forest A. Gonyer, analyst)

Constituent	*Per cent*	*Ratios*			
SiO_2	35 82	594	.594	.198 × 3	.98 × 3
Al_2O_3	21 39	209	.218	218 × 1	1 08 × 1
Fe_2O_3	1 44	009			
FeO	21 58	.300	.596	.199 × 3	.99 × 3
MgO	48	012			
MnO	17 15	242			
CaO	2 34	042			
	100 20				

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[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received November 17 1927.

It will be seen from the analysis that the garnet is a member of the almandite-spessartite series and contains the ferrous iron molecule a little in excess of the manganese molecule. Most all garnets from granitic pegmatites belong to this series. When the bases are combined in constituent molecules, the following mineralogical composition is derived from the analysis:

Molecule	*Formula*	*Ratio*	*Per cent*
Almandite	$3FeO\ Al_2O_3\ 3SiO_2$	100	49.87
Spessartite	$3MnO\ Al_2O_3\ 3SiO_2$	081	40.17
Andradite	$3CaO\cdot Fe_2O_3\ 3SiO_2$	009	4.58
Grossularite	$3CaO\cdot Al_2O_3\cdot 3SiO_2$	005	2.26
Pyrope	$3MgO\ Al_2O_3\ 3SiO_2$	004	1.62
Alumina (excess)	Al_2O_3	019	1.82
			100.32

The calculated index of refraction of a garnet of the above composition, excluding the excess alumina and using Ford's data for the end members, is 1.816 while the index of refraction of the analyzed powder was found to be 1.808.

The ratios of the first table show that the silica almost exactly balances the bivalent bases whereas the trivalent bases are a little too high to conform exactly with the garnet formula and show an excess of 1.82 per cent of alumina in the second table. Many analyses of manganese-bearing garnets present a deficiency of trivalent bases, and to conform to the general garnet formula $3R''O\cdot R'''_2O_3\cdot 3SiO_2$ it is necessary to assume some of the manganese to be present in the trivalent state. As shown in a previous communication,[3] the deficiency may at times be due to analytical error. In the present analysis the basic acetate method for separation of manganese from iron and alumina was not used, the iron and alumina being precipitated only by ammonia. The results showed trivalent bases high instead of low, as is usual when the acetate method is employed. The whole analysis was then repeated and the results checked with the greatest care. As manganese is the most troublesome element in such an analysis, the additional amount of manganese in the weighed iron and alumina was determined. The precipitate obtained from the final ammonia precipitation was ignited, weighed, fused with potassium bisulphate, and obtained in sulphate solution in the usual manner. The solution was then made up to a volume of 250 cubic centimeters in a calibrated flask. One fifth (50 cubic centimeters) of the solution was withdrawn with a pipette and the manganese in it determined colorimetrically. The balance of the solution was reduced, titrated for iron, and tested for titanium as usual. Minor amounts of manganese contaminating the lime and magnesia precipitates were likewise colorimetrically estimated and appropriate corrections made. The results were highly satisfactory and it has been concluded to avoid the use of the basic acetate method in future analyses.

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[3] EARL V. SHANNON, *"Blythite" and the manganese garnet from Amelia, Virginia.* Journ. Wash. Acad. Sci. 17: 444-453. 1927.

MINERALOGY.—*Natrojarosite from Kingman, Arizona.*[1] EARL V. SHANNON and FOREST A. GONYER.

Since the discovery that jarosite or members of the jarosite group of minerals are unusually common in the oxidized portions of ore deposits, especially in desert regions or areas of more or less arid climate, the interest in this group has increased among geologists and practical mining men as well as among mineralogists. Following the description of the original potash jarosite there were found, almost simultaneously, other analogues of the compound in which soda and lead were essential bases. The lead compound, plumbojarosite, has in numerous places been worked as an ore of lead, and a variety occurring in small amount at the Boss mine, Nevada, proved to contain relatively very large amounts of platinum and palladium. In addition to these most interesting minerals, analogues of jarosite in which the potash is replaced by silver oxide and ammonium oxide have recently been found in Utah. In appearance these jarosites are so similar that they cannot be distinguished from each other without chemical tests. Although distinct and measurable crystals have been found, the minerals usually vary from yellow to brown in color, are more or less earthy in texture, and have in many cases been mistaken for earthy limonite. The finer-grained examples are dull in luster, but the coarser varieties are usually silky or satiny in lustre.

A large lot of specimens of a jarosite was received at the National Museum from Mr. W. F. Smith, of Kingman, Arizona. The locality is given as the Georgia Sunset mining claim, ¾ mile east of McConnico, a station on the Santa Fe Railroad in Mohave County, 4 miles south of Kingman. Since the material was pure and in good specimens which it was desirable to preserve in the collections, it was analyzed. A representative specimen of the purer material was ground, and when examined under the microscope was found of satisfactory quality. The analysis gave the following results:

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[1] Published by permission of the Acting Secretary of the Smithsonian Institution. Received November 17, 1927.

ANALYSIS AND RATIOS OF NATROJAROSITE

Constituent	*Per cent*	*Ratio*		
Insoluble	22			
Fe_2O_3	48 23	302	303	1 01 × 3
Al_2O_3	09	001		
FeO	.58	008	103	1.03 × 1
CaO	05	001		
MgO	05	001		
Na_2O	4 28	069		
K_2O	2 28	024		
Ag_2O	none			
PbO	trace			
$(NH_4)_2O$	none			
SO_3	33 71	421	.421	1 05 × 4
H_2O	10 76	597	597	.99 × 6
	100 25			

The ratios give the formula for natrojarosite, $(Na,K)_2O \cdot 3Fe_2O_3 \cdot 4SO_3 \cdot 6H_2O$. The material is free from more than traces of silver and lead although a larger sample might have shown precious metals upon assay.

The material is compact to earthy and golden-brown to yellow. The more friable and lustreless portions greatly resemble common yellow ocher. Other specimens consist of a greatly altered, kaolinized or sericitized, and bleached igneous rock heavily impregnated with pyrite. Others are similarly altered rock from which the pyrite has decomposed, leaving jarosite obviously derived by oxidation from the pyrite.

Under the microscope the mineral is clean, transparent, greenish-yellow, and nonpleochroic with high birefringence. The powder is made up of tabular crystal grains, many of which show hexagonal or rhombohedral boundaries. Many of the crystals lie on their basal plane and since these are dark in all positions between crossed nicols the mineral is uniaxial, or nearly so, and is negative. The indices of refraction measured are: $\omega = 1.829$, $\epsilon = 1.760 \pm 0.002$. The differences in optical properties between the several members of the group are not such that they can be differentiated microscopically.

PETROLOGY.—*Rocks of the Galápagos Islands.*[1] H. S. WASHINGTON and MARY G. KEYES, Geophysical Laboratory, Carnegie Institution of Washington.

In 1923 the Harrison Williams expedition of the New York Zoological Society visited the Galápagos Islands, where extensive zoological collections were made.[2] Dr. Beebe, Director of Scientific Work, was so good as to collect some of the rocks, in spite of the very limited time at the disposal of the expedition. For this and for his kind permission to describe some of the specimens we would express our hearty thanks.

This small group of wholly volcanic islands, lying on the equator about 500 miles west of Ecuador, was first made known to science by Charles Darwin, who visited them in 1835 during the famous cruise of the *Beagle* and described them in a classic chapter.[3] Since then several other expeditions have visited the group, as noted by Beebe in his book cited above. Most of these expeditions were for zoological and botanical purposes and, apart from Darwin's masterly observations, the literature on the petrography of the islands is very scanty. Of the papers that deal especially with the rocks of the islands there appear to be but two that need to be mentioned here and that are not included in Beebe's bibliography. One is a paper by Gooch[4] describing a set of specimens given him as a student by Tschermak; the other is a brief report by Merrill[5] on a small collection of rocks made during the *Albatross* expedition in 1891. Neither Zirkel nor Rosenbusch do more than make very brief mention of the "palagonite" tuff.

Darwin estimated the number of craters at about 2,000, and several of them have been in eruption during the last hundred years or so.[6] The lavas, in general, have been considered to be basaltic, with the peculiar yellow tuff described by Darwin, but the papers by Gooch and by Merrill give indication that there may be considerable variety, as will be noted later. The specimens especially studied by us were collected by Beebe on Eden, an islet off the northwest coast

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[1] Received November 19, 1927

[2] WILLIAM BEEBE, *Galapagos. World's End* New York, 1924.

[3] DARWIN, *Geological Observations*, 3rd ed, London, pp. 110–131, 1891.

[4] FRANK A. GOOCH, Tsch Min. Mitth. 6: 133. 1876.

[5] MERRILL, Bull Mus Comp. Zool. 16: 235 1893.

[6] See SAPPER, *Katalog der geschichtlichen Vulkanausbrüche*, p. 95, 1917. Also BEEBE, op. cit, pp 411, 412, (ca 1912, 1897). These two eruptions are not mentioned by Sapper.

of Indefatigable. They consist of basalt and of the peculiar yellow tuff; the other specimens were so altered as scarcely to repay study.

Basalt.—The rock is dense, non-scoriaceous, and very fine-grained, but not aphanitic, small glistening crystals of feldspar being visible through the mass. The color is very dark brownish gray—almost black. A few very small phenocrysts of feldspar are seen here and there. In thin section, the texture is seen to be ophitic, the rock being made up of tables of andesine (about Ab_3An_2), with interstitial, anhedral, pale brown, non-pleochroic augite, and very few rather larger rounded olivines. There is no magnetite, but considerable darkish brown glass in interstitial patches. A narrow rim of the glass surrounds the olivines.

TABLE 1.—BASALTS OF GALÁPAGOS AND OF HAWAII

	(1)	(2)	(3)
SiO_2	48 24	48 04	48 42
Al_2O_3	15 82	15 35	13 97
Fe_2O_3	0 78	5 72	4 17
FeO	9 84	7 67	9 57
MgO	5 84	5 77	4 61
CaO	9 84	10 13	8 86
Na_2O	3 63	3 26	3 30
K_2O	0 64	0 79	1 29
H_2O+	0 72	0 27	0 84
H_2O-	0 11	0 04	0 42
TiO_2	3 88	3 13	3 25
P_2O_5	0 16	0 33	0 91
MnO	0 20	0 10	0 17
	99 70	100 62	99 78
NORMS			
Q	——	——	0 84
Or	3 89	4 45	7 78
Ab	29 87	27 77	27 77
An	25 02	24 74	19 46
Ne	0 28	——	——
Di	18 67	18 65	15 49
Hy	——	8 91	12 88
Ol	11 98	0 76	——
Mt	1 16	8 35	6 03
Il	7 45	5 93	6 23
Ap	0 34	0 67	2 02

(1) Andesine basalt, Eden Islet, Galápagos Islands Keyes analyst

(2) Andesine basalt, Hualalai, Hawaii Washington analyst Am Journ Sci. 6: 104 1923.

(3) Andesine basalt, Mauna Kea, Hawaii Washington analyst Am Journ Sci. 5: 493 1923.

The chemical composition of this basalt is shown in No. 1 of Table 1. The analysis is that of a normal basalt, which may be matched by several of the basalts of Hawaii, as shown in Nos. 2 and 3 of Table 1. The only features worthy of special mention are the great preponderance of FeO over Fe_2O_3, and the high Na_2O and TiO_2.

Tuff.—Darwin devotes considerable space to the description and discussion of the origin of "a singular kind of tuff," which forms craters on Chatham and James Islands. This is the so-called "palagonitic" tuff of Bunsen, Zirkel, and Rosenbusch. All the specimens examined by us came from the small islet of Eden.

This tuff is very dense and compact, but most specimens can be readily scratched with a knife, having a hardness of 3 to 4. The color is a rather light, yellowish brown and the luster is peculiar—greasy or, as Darwin puts it, resinous. Fragments are slightly translucent on thin edges. The mass contains very small (1 to 2 mm.) grains of black augite and also fragments of basaltic lava, some of them scoriaceous.

The making of coherent thin sections of this tuff, using the most compact specimen, proved a matter of much difficulty, as the section broke up and spread into a number of detached pieces. The greater part of the material is composed of small angular fragments of clear bright yellow glass, slightly mottled, the average index of refraction being 1.585, as kindly determined by Dr. Merwin. This glass contains a few small inclusions, some of them of augite and some indeterminable, with a few small ellipsoidal vacuoles. These glass fragments are separated by a white doubly refracting mineral of very low refractive index, which appears to be zeolitic. The presence of this accounts for the peculiar action of the section. A few grains of olivine and one or two of augite are seen.

An analysis of a compact specimen, free from basalt fragments and from veinlets of calcite, is given in No. 1 of Table 2, with one of a similar tuff made by Bunsen in 1851, and several analyses of similar rocks. In No. 1 the low SiO_2, MgO, and K_2O are noteworthy, and it is very evident that the iron is almost wholly in the ferric state. The amount of H_2O (both + and −) is remarkably high, the two together making up almost 21 per cent of the rock. Unquestionably much of this belongs to the rather abundant zeolitic material, but some of it is also probably contained in the glass. The complete absence of CO_2 in such a hydrated tuff is noteworthy. The analysis by Bunsen, one of three made some 75 years ago, is of only historic interest, but in its general outlines it greatly resembles the recent one and is evidence of Bunsen's accurate work, given the facilities and methods of the time.

As compared with analyses of similar rocks composed mainly of yellow glass, some analyses of which are given in the table, the Eden tuff is much less alkalic than the yellow tuff of San Felix (No. 3), which is derived from a nephelite basanite, and differs in other respects, especially in Al_2O_3 and MgO. If it is assumed that there has been no loss or other considerable change in the bases and if the analysis (No. 1) is calculated to 100 per cent on an H_2O-free and CO_2-free basis (No. 5), the result differs along much the same lines from the analysis of a palagonite of Sicily (No. 4), this being an altered basaltic glass occurring in basaltic tuffs, but peculiar because of its highly sodic character and low water content. On the whole, the Galápagos tuff, calculated to 100 per cent, most resembles the tuffs of the island of Linosa, which are derived from feldspathic basalts.

TABLE 2.—Analyses of Palagonitic Tuffs

	(1)	(2)	(3)	(4)	(5)	(6)
SiO_2	38.13	38.07	36.35	48.90	47.75	46.58
Al_2O_3	14.64	13.03	8.14	13.80	18.34	18.61
Fe_2O_3	7.93	9.99	5.57	5.77	9.94	7.43
FeO	0.87	——	3.50	6.84	1.09	3.73
MgO	3.84	6.58	9.05	8.85	4.78	7.93
CaO	8.97	7.54	7.44	7.27	11.25	8.14
Na_2O	2.67	0.70	4.70	5.32	3.34	3.85
K_2O	0.15	0.94	3.25	0.96	0.19	0.72
H_2O+	12.34	23.14	4.01	1.65	——	——
H_2O-	8.41		8.35	——	——	——
CO_2	none	n.d.	4.00	trace	——	——
TiO_2	2.50	n.d	4.76	0.71	3.12	3.01
P_2O_5	0.01	n.d	0.83	0.04	0.01	——
MnO	0.15	n.d	n.d	trace	0.19	——
	100.61	100.00	99.95	100.11	100.00	100.00

(1) Palagonitic tuff, Eden Islet, Galápagos Islands. Keyes analyst.

(2) Palagonite, Galápagos Islands. Bunsen analyst. Ann. Chem. Pharm. **83**: 221. 1851. (Calculated to 100.)

(3) Basanite tuff, Cerro Amarillo, San Felix Island. Washington analyst. Bull. Geol. Soc. Amer. **35**: 381. 1924.

(4) Palagonite ("Basalt glass"), Palagonia, Sicily. Ponte analyst. Atti Accad. Gioenia (**5**) **3** (10): 7. 1910.

(5) Analysis No. 1 calculated to 100.00, as free from H_2O.

(6) Yellow basalt tuff, Monte Pozzolana, Linosa Island. Calculated to 100.00, as free from H_2O and CO_2. Washington analyst. Journ. Geol. **16**: 29. 1908.

So, although the evidence may not be conclusive because of the small number of specimens, yet it may be assumed that this peculiar yellow Galápagos tuff, or rather the predominant glass, is derived from basaltic rather than from tephritic lavas. At the same time, these yellow basaltic or tephritic glasses are so peculiar that the term "palagonitic" may well be applied to them.

The origin of these Galápagos tuffs was a source of much speculation to Darwin, who finally concluded that they were "produced by the grinding together of fragments of lava within active craters, communicating with the sea." The modern methods of study of rocks in thin section, unknown in his day, do not bear this out, but indicate, rather, that these and similar palagonitic rocks are much altered basaltic (or tephritic) glasses. The subject will be taken up again when specimens collected in the Val di Noto, Sicily, are studied.

Conclusions.—In so far as the material at our command permits us to judge, it would appear that the lavas of the Galápagos Islands are chiefly andesine (and probably also labradorite) basalts, with their peculiar tuffs, which latter, as stated by Darwin "present the most striking feature in the geology of this Archipelago." At the same time the few brief notes given us by Gooch and Merrill indicate some features of greater complication and of especial interest as bearing on the relations of this group of volcanic islands to others of the Pacific. Both of these authors describe most of their specimens as being ordinary feldspar basalts, and Gooch explicitly states that nephelite was not observed in any of the specimens examined by him. Gooch, however, very briefly notes some pumice[7] containing orthoclase, from Indefatigable and Abingdon.[8] Determinations by Gooch on the Indefatigable pumice showed 61.48 per cent of SiO_2 and 12.45 per cent of loss on ignition. The rock is, therefore, obviously trachytic or rhyolitic. Merrill also briefly describes an "andesite (?)" from Cocos Island, of which a "rough analysis" yielded the following results: SiO_2, 56.50; Al_2O_3, Fe_2O_3, 28.20; CaO, 2.83; MgO, 0.98; K_2O, 4.25; Na_2O, (by difference) 6.68; Sum, 99.44. The rock contained Cl "derived presumably from ocean spray." He remarks that "this indicates that the rock is more nearly related to the andesites than trachytes, though abnormally rich in potash." In other words, the rock appears to be trachyandesitic.

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[7] GOOCH, op. cit., p. 137.

[8] Darwin states that he could find no pumice or trachyte on any of the islands.

These two observations, scanty as they are, show clearly that not only are the lavas of the Galápagos more complicated and varied than has been generally thought, but—and this is a matter of especial importance—that there is much similarity between their lavas and those of most of the Intro-Pacific volcanic islands. Thus, we find such "trachyandesites" at Hawaii and at other islands, and moreover trachytic lavas occur with basalts at many of them;[9] as on Hawaii, Maui, Molokai, in the Hawaiian Islands; Tutuila in the Samoan group; Tahiti; Juan Fernandez Islands; San Felix; Nukuhiva, Marquesas; and several others. A "phosphatized trachyte" is known from Clipperton Atoll, many hundred miles north of the Galápagos.[10]

This very general occurrence of trachytic and trachyandesitic lavas with dominant basalts is a feature of the petrology of the Pacific of very great importance, and one that appears to be of great bearing on some problems of geophysics. But it cannot be discussed here. It need only be said that thorough study of the lavas of the Galápagos Islands is highly desirable.

PALEONTOLOGY.—Pycinodesma, *new name for* Pycnodesma *Kirk not Schrammen.*[1] EDWIN KIRK, U. S. Geological Survey.

Under the title "*Pycnodesma,* a new molluscan genus from the Silurian of Alaska," (Proc. U. S. Nat. Mus. 71; Art. 20, No. 2692. 1927) I proposed the generic name *Pycnodesma.* This name had been used by Schrammen for a Cretaceous sponge, and I therefore propose the name *Pycinodesma,* with *Pycinodesma giganteum* Kirk as the genotype, for this group of Silurian pelecypods.

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[9] The references need not be given here Some of the observational and analytical data are as yet unpublished.

[10] TEALL, Quart. Journ. Geol Soc. 44: 230. 1898

[1] Published by permission of the Director, U. S. Geological Survey. Received November 17, 1927.

ENTOMOLOGY.—*New species of American Lepidoptera of the families Limacodidae and Dalceridae.*[1] HARRISON G. DYAR, U. S. National Museum. (Communicated by AUGUST BUSCK.)

The species here mentioned will be discussed more fully in other places, but it is desirable to validate the names as soon as possible.

Family LIMACODIDAE

Genus APODA Haworth

Apoda maxima, new species

Fore wing ocher-brown to reddish brown, the terminal area slightly paler than the basal one, or not so; a dark, somewhat oblique line across the middle, edged with whitish without. Hind wing a shade lighter than fore wing Expanse, male, 27 mm., female, 28 mm.

Male and female, Type No. 40665, U. S Nat. Mus , Big Bend, Brewster County, Texas, 5000–7000 feet alt (O. C. Poling, gift of F. Johnson).

Genus SIBINE Herrich-Schäffer

Section 1. *Anellus of male hypopygium with a dorsal chitinous tongue*

Sibine clarans, new species

Fore wing narrow, elongate, rather pointed; dark rufous brown, the veins, especially median and at base, blackish shaded; three white subapical dots, one small subbasal dot. Hind wing rosy whitish, inner area rosy brown. Expanse, male, 38 mm Anellus with a horn on each side.

Two males, Type No 40666, U. S. Nat. Mus., No 860, Cornell University Coll., Yahuarmayo, Peru, 1200 feet, alt., April, 1912 (Dognin Collection); El Campaniente, Col Perene, Peru, June 14, 1920 (Cornell Univ Exp.).

Sibine dorans, new species

Like *clarans;* a little less rufous Male anellus without horns, spines of penis a wide mass of small ones

Five males, Type No. 40667, U S. Nat Mus , La Oroya, Rio Inambari, Carabaya, Peru (Dognin Collection).

Sibine tontineans, new species

Similar to *clarans* and *dorans,* anellus without horns, spines of penis in a line, small at base, very large in the middle, small again at tip. Expanse, male 33–35 mm.

Two males, Type No. 40668, U. S. Nat Mus , St. Jean du Maroni and Nouveau Chantier, French Guiana (Le Moult, Dognin Collection).

Sibine giseldans, new species

Like *tontineans,* but much smaller in size. Expanse, male, 29 mm. Spines of penis a mass of very long slender ones.

One male, Type No. 859, Cornell Univ. Coll., below Rio Negro, Amazonas, Brazil, September, 1920 (Cornell Univ. Exp).

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[1] Received November 12, 1927

Sibine joyceans, new species

Fore wing trigonate, rather short, dark, less reddish than in *horrida;* dots white, the subapical ones consolidated in an oblique line; hind wings rather dark. Expanse, male, 30–33 mm , female, 40–43 mm Spines of penis numerous terminally, small, the basal ones few and large

Five males, two females, Type No. 40669, U. S Nat. Mus , Panama (Busck and Zetek).

Sibine iolans, new species

Dark rufous brown as in *pallescens* Dogn (= *rufescens* Walk.). Male without dots or markings Hind wing pale rosy brown Expanse, male 31–35 mm. Male hypopygium as in *nitens*, the spines of penis more slender and numerous

Three males, Type No 40670, U. S Nat Mus , Paramaribo, Surinam, May, 1904 (W. Schaus); Cayenne, French Guiana, June, 1904 (W Schaus), French Guiana, 1900 (Pouillon).

Sibine norans, new species

Dark rufous brown without dots; hind wing dark brown Male hypopygium as in *pallescens* (= *rufescens*), but the harpe finger-shaped at tip, oblique on one side. Expanse, male, 30–40 mm , female, 43–45 mm.

Eleven males, three females, Type No 40671, U. S. Nat Mus , São Paulo, Castro and Santa Catherina, Brazil, Paraguay (Schaus and Dognin Collections).

Sibine didactica, new species

Smaller than *norans*, similarly marked, two subapical and one subbasal white dots. Male aedoeagus a very narrow tube, much narrower than in *nitens*, etc

One male, Type No. 40672, U S Nat Mus , from the British Guiana Museum, presumably collected in that country.

Sibine ximenans, new species

Dark purple brown like *nitens*, the dots minute; hind wing very dark. Male hypopygium as in *joyceans*, the spines of penis numerous throughout, long and about alike. Expanse, male, 32 mm

One male, Type No. 40673, U. S. Nat. Mus , Rio Tocantins, Brazil (Dognin Collection) Another male in the Cornell University Collection is not made an allotype because the number of spines of the penis is much less La Merced, Rio Chamchamayo, Peru, June 3, 1920 (Cornell Univ. Exp.).

Sibine violans, new species

Rather large, dark shining purple brown; dots pale yellow, large, and tending to confluence. Hind wing dark red-brown, the scales purplish and raised between the veins Expanse, male, 33–35 mm , female, 48 mm Generally similar to *bonaerensis* Berg, larger and more brilliantly marked

Two males, one female, Type No. 40674, U S. Nat Mus , Muzo, Medina, and Pacho, Colombia (A. H. Fassl, Dognin Collection).

Sibine helenans, new species

A small species, smooth dark purple brown. Expanse, male, 25–28 mm., female, 40–42 mm. Male hypopygium as in *bonaerensis* Berg, but the wing-shape different, the present species having pointed fore wings.

Three males, Type No. 40675, U. S. Nat. Mus., Rurrenebaque, Bolivia, October, 1922 (W. M. Mann, Mulford Biological Exp.); Teffé, Amazonas, Brazil, September (A. H. Fassl, Dognin Collection). Also 14 males and three females examined from the Cornell University Collection from various localities on the Amazon and from Corumba, Matto Grosso, Brazil.

Sibine priscillans, new species

Large, rather light rufous brown, with red stain subapically and subbasally, single subapical and subbasal yellowish dots. Hind wing pale creamy. Expanse, male, 43 mm. Male hypopygium of the type of *violans*, *ximenans*, etc.

One male, Type No. 40676, U S. Nat. Mus , Zacualpan, Mexico, November, 1914 (R. Muller, Dognin Collection).

Sibine laurans, new species

Blunt-winged, rather light purple brown, the fringe dark; a large orange-red shade along inner margin below a darker ray; no subapical marking, no dots. Expanse, male, 28 mm.

Two males, Type No 40677, U. S. Nat Mus , São Paulo Olivença, Amazonas, Brazil, November–December (A. H. Fassl, Dognin Collection)

Section 2. *Male anellus without dorsal chitinized tongue*

Sibine reletiva, new species

As in *extensa* Schaus; smaller, the spines of the male penis shorter but large and stout and followed by minute ones. Expanse, male, 30–35 mm., female, 40 mm.

Three males, one female, Type No. 40678, U. S. Nat Mus., San Salvador, Central America (Dognin Collection).

Sibine ophelians, new species

As in *extensa*; blunter winged, somewhat less strongly marked and thinner scaled. Expanse, male, 30–35 mm., female, 46–50 mm. Hypopygium as in *reletiva*, the spines of penis fine, slender, not followed by minute ones.

Twelve males and three females, Type No. 40679, U S. Nat. Mus., San Salvador, Salvador; Cayuga and Quirigua, Guatemala; Juan Vinas and Sixola River, Costa Rica (Schaus & Barnes); Lino, Panama, Pacho, Colombia (Dognin Collection).

Sibine gertrudans, new species

Blunt-winged, dark umber brown with little reddish tint; a blackish ray through cell and along submedian, dots obsolete. Hind wing purplish brown. Expanse, male, 30–35 mm. Hypopygium similar to *extensa*, the spines of the penis smaller. The wing-shape differs

Eight males, Type No. 40680, U. S. Nat. Mus., Cuernavaca, Morelos, Mexico, July, August, November, December, 1906 (W. Schaus); Colima, Colima, Mexico, July, 1924 (R. Müller).

Sibine quellans, new species

Fore wing pointed, dark shining brown with contrasting areas; subbasal and subapical reddish stains, no dots. Hind wing rather dark brown. Expanse, male, 30 mm.

One male, Type No. 40681, U. S. Nat. Mus., San Antonio, Colombia, 5800 feet alt., December, 1907 (M. G. Palmer, Dognin Collection).

Sibine rollans, new species

Blunt- and square-winged; light rosy red-brown; a narrow blackish ray from base below cell, the inner area below it bronzy red. Hind wing rather brightly reddish brown. Expanse, male, 25-27 mm.

Eight males, Type No. 40682, U. S. Nat. Mus., St. Jean and St. Laurent, French Guiana (Le Moult); Yahuarmayo, Peru, April-May, 1912; Codajias, Coary and Teffé, Amazonas, all from the Dognin Collection. Also 9 males in the Cornell University Collection, not mounted, but agreeing superficially, Mackenzie, Demerara River, British Guiana, June 24, 1927; Tumatumari, Potaro River, British Guiana, June 27, 1927; Moengo, Cottica River, Surinam, May 23, 1927 (Cornell Univ. Exp.).

Sibine francesans, new species

Like *eucleides* Dyar, the wing even broader and squarer; a little less dark brown, the black ray under median vein more distinct. Expanse, male, 36 mm.

Two males, Type No. 40683, U. S. Nat. Mus., one without label, the other, Rio Songo, Bolivia (A. H. Fassl, Dognin Collection).

Sibine zellans, new species

Fore wing narrow, pointed, hind wing trigonate, the outer margin straight; dark purplish brown, no markings, the hind wing almost as dark as the fore. Expanse, male, 37 mm. Hypopygium with the two limbs of the aedoeagus irregular, one shorter than the other, the limbs quadrate, granular.

One male, Type No. 40684, U. S. Nat. Mus., Pará, Brazil (Moss)

Sibine berthans, new species

Like *zellans*, blacker, wings rather less pointed, the outer margin of hind wing convex. Female less intensely blackish, the ground brownish in places, a red apical stain, and subapical yellow streak on vein 6, hind wing lighter brown. Expanse, male, 34 mm., female, 54 mm. The spines of the penis are finer and more numerous than in *zellans*.

Male and female, Type No. 40685, U. S. Nat. Mus., Villa Rica, Paraguay, March, 1926 (F. Schade).

Sibine sarans, new species

Small, dark, blunt-winged, resembling *stimulea* Clem. Hypopygium as in *zellans*, but the limbs of aedoeagus slender, irregular. Expanse, male, 23 mm. Hypopygium much as in *pauper* Dyar.

One male, Type No. 40686, U. S. Nat. Mus., San Sebastian Retalhuleu, Guatemala (L. Thiel).

Genus EUCLEA Hubner

Euclea cassida, new species

Fore wing with light yellow ground, the scales suberect and thin; blotched with blackish, especially at base, and defining a pale pinkish patch between the subapical silver dots and subbasal strongly waved line; no discal dot visible. Expanse, male, 23–24 mm.

Two males, Type No 40687, U. S. Nat. Mus., Amathura and Caicara, Amazonas, Brazil (Dognin Collection).

Genus TALIMA Walker

Talima sissypha, new species

As in *straminea* Schaus, but the whole wing darkened with purple-brown; inner and outer margins darker. Expanse, male, 21 mm

One male, Type No. 40688, U. S. Nat. Mus, San Sebastian, Retalhuleu, Guatemala (L. Thiel).

Talima varians, new species

As in *flexilinea* Dyar the fore wing light purple brown, darker shaded at base; veins outwardly dark, crossing the slender flexuous outer line; apex broadly dark purple-brown beyond the line; hind wing rather pale stramineous, with a purple area across the middle. Expanse, female 23 mm.

One female, Type No 40689, U. S. Nat Mus., Venezuela (Dognin Collection).

Talima merilone, new species

Like *emilia;* larger, the fore wing heavily suffused, the veins not lined; a round clouded discal area Expanse, male, 22–23 mm

Two males, Type No. 40690, U S. Nat Mus, Colombia: Micay, August, 1896, Pueblo Rico, San Juan Choco, 5200 feet alt, September, 1909 (Dognin Collection).

Talima insulla, new species

Like *sulla* Schaus, but the outer dark line absent, replaced by a narrow pale yellow shaded line, which is rather faint in the male, distinct in the female. Expanse, male, 20 mm., female, 26 mm.

Two males, one female, Type No. 40691, U. S. Nat Mus., Type No. 857, Cornell Univ. Coll., below Codajos, Rio Solimões, Brazil, September 6, 1920 (Cornell Univ. Exp.).

Genus MONOLEUCA Grote & Robinson

Monoleuca angustilinea, new species

Fore wing uniform red-brown; silvery line erect, sulphur-yellow tinted, narrow, slightly oblique, entering cell before origin of vein 2, preceded by faint reddish. Expanse, female, 23 mm.

One female, Type No. 40692, U. S. Nat. Mus., Capron, Florida, March 23 (H. G. Hubbard).

Genus SISYROSEA Grote

Sisyrosea brusha, new species

Fore wing dark purplish brown, sparsely sprinkled with black scales; hind wing distinctly blackish. Expanse, male, 20 mm.

Two males, Type No. 40693, U. S. Nat Mus, Jalapa, Mexico (W. Schaus) Godeberi, Maroni River, French Guiana (Le Moult).

Genus NATADA Walker

Natada styx, new species

Like *deba;* darker brown, the lines obscure, divergent below; hind wing blackish. Expanse, male, 25 mm.

One male, Type No. 40694, U. S. Nat. Mus, Yahuarmayo, Peru, April, 1912 (Dognin Collection).

Natada ulaula, new species

Like *michorta;* larger, darker, the indicated transverse lines farther apart and less numerous. Expanse, male, 30 mm

One male, Type No. 40695, U. S. Nat. Mus, Medina, Colombia, 500 m alt. (A H. Fassl).

Genus PEROLA Walker

Perola prosper, new species

Fore wing white, overlaid with olive brown, leaving a broad submarginal white band with rather irregular edges; white mottlings about cell and marginally; a dark dot in base of cell and large discal spot. Hind wing whitish. Expanse, male, 24–25 mm.

Three males, Type No 40696, U S Nat Mus; Type No 856, Cornell Univ Coll., "Lassance," Minas Geraes, Brazil, November 9, 1919 (Cornell Univ Exp.).

Perola subpunctella, new species

Like *subpunctata* Walk.; smaller. Expanse, male, 20–22 mm

Seven males, Type No. 40697, U. S. Nat. Mus, Castro, Paraná, Brazil, (E. D. Jones); Villa Rica, Paraguay, February 9, 1921 (C Jorgensen).

Genus ALARODIA Möschler

Alarodia minuscula, new species

White, without markings, fore wing below smoky shaded, darkest along costa Expanse, male, 11 mm.

One male, Type No. 40698, U. S Nat. Mus., Matanzas, Cuba, November, 1902 (W. Schaus).

Genus SEMYRA Walker

Semyra erna, new species

Markings of *eucharista*, but darkened, the silvery bar more distinct, hind wing blackish brown Expanse, male, 17–19 mm

Four males, Type No. 40699, U. S Nat Mus, Villa Rica, Paraguay (F. Schade).

Semyra lucilla, new species

Markings of *gladys*, the whole wing dark purple-brown, the spots distinct, although not contrasted. Hind wing brownish black Expanse, male, 25 mm.

One male, Type No 40700, U S. Nat Mus, Venezuela (Dognin Collection).

Genus Isochaetes Dyar

Isochaetes ashtabel, new species

Fore wing dark purple brown, hind wing bronzy black; some rufous patches basally; a black highly angled zig-zag line crossing the wing centrally, rufous-edged without, and below the median vein forming a deep excavation; a dark outer line excurved over cell inclosing a curved pale space at end of cell, which is ovate in its upper half, obscured except for two whitish patches below. Expanse, male, 18 mm , female, 26 mm.

Male and female, Type No 40701, U. S. Nat Mus ; Type No. 855, Cornell Univ. Coll , male, Molinas, Paraguay, October, 1925 (F. Schade), female, Rockstone, Essequibo River, British Guiana, June, 1927 (Cornell Univ. Exp.).

Genus Venadicodia Dyar

Venadicodia ruthaea, new species

Fore wing brownish; basal space dark brown; a darker oblique bounding line from costa before middle to inner margin beyond middle; a little whitish in its irregular outer edge, outer area light brown; a small brown patch at apex, continued narrowly along termen Hind wing blackish brown. Expanse, male, 18 mm.

One male, Type No. 40702, U. S. Nat. Mus , without locality (Schaus Collection)

Family DALCERIDAE

Genus Dalcera Herrich-Schäffer

Dalcera consanguinea, new species

Fore wing pale purple, shading to blackish outwardly; costal margin, inner and outer margins narrowly, pale yellow. Hind wing orange yellow with a narrow outer black border, in width less than one-fourth the length of the wing. Expanse, male, 39–45 mm

Two males, Type No 40713, U. S. Nat. Mus., Rio Tapajoz, Amazonas, Brazil; Porto Velho, Rio Madeira, Brazil (Dognin Collection).

Perhaps not distinct from *Dalcera semirufa* Druce, which I know only by description.

Genus Acraga Walker

Acraga perbrunnea, new species

Dark purple, uniform, the hind wings apparently of the same color, though badly denuded in the specimen. Expanse, male, 25 mm.

One male, Type No. 40714, U S. Nat. Mus., Oxapampa, Peru, 2000 m. alt. (Dognin Collection).

Genus Anacraga Dyar

Anacraga citrinopsis, new species

Color of *citrina* Schaus, but considerably larger. Expanse, male, 25 mm.

One male, Type No. 40715, U. S. Nat. Mus., Callao, Peru (Mrs. M. J. Pusey)

Anacraga ingenescens, new species

Fore wing dull golden yellow, color of *ria* Dyar (*luteola* Hopp); hind wing pale yellow, more golden on the margin. Expanse, female, 32 mm

One female, Type No. 40716, U. S. Nat. Mus., Merida, Venezuela (Dognin Collection).

Anacraga sororcula, new species

Like *sofia* Dyar, smaller, most of the wing markings except the discal dot faint and obsolescent Expanse, male, 12 mm, female, 16–17 mm.

Four males, two females, Type No. 40717, U S Nat Mus, Cayuga, Guatemala, May, September, October (Schaus & Barnes); Misantla, Mexico, September, 1910 (R Müller).

Anacraga phasma, new species

White faint yellowish clouded markings on lower half of wing; no discal dot. Expanse, female, 17 mm

One female, Type No. 40718, U S Nat. Mus., Venadio, Sinaloa, Mexico (A. Kusche).

Genus PROTACRAGA Hopp

Protacraga nigerella Dognin

Dognin's *Dalcera nigerella* is apparently the male of Hopp's *Protacraga micans.*

Genus MINONOA Dyar

Contains the following species:

Minonoa perbella Schaus (genotype)

Minonoa variegata Jones (*Dalcera variegata* Jones)

I have not examined specimens of this species, but feel sure from the wing shape and pattern of coloration that it will find place in this genus.

Minonoa elvira Dognin (*Acraga elvira* Dognin)

Dognin's types are before me The disparity in the sexes in color and even pattern of markings is remarkable.

SCIENTIFIC NOTES AND NEWS

The annual series of lectures representative of the work of the Carnegie Institution of Washington was given in November and December, and included the following: November 15, OSCAR RIDDLE, *Internal secretions in evolution and reproduction;* November 22, J. P. AULT, *Purpose and progress of ocean surveys;* November 29, REMINGTON KELLOGG, *History of whales—their adaptation to life in the sea;* November 30, S. G. MORLEY, *Excavations at Chichen Itza, Yucatan, Mexico, and at Uaxactun, Peten, Guatemala, in 1927* (presented at the Bureau of American Republics); December 6, WALTER S. ADAMS, *The interior of a star and how it maintains its life.* The annual reception and exhibit of apparatus and methods was held on December 9.

Obituary

Mr. FRANK SPRINGER, a member of the ACADEMY, died September 22, 1927, at the age of seventy-nine. Mr. Springer was born in Iowa and received his earlier education in that state. As a young man he moved to New Mexico and soon became prominent as a lawyer, a successful business man, and a participant in public affairs. An interest in the study of the fossil crinoids aroused in his younger days in Iowa, however, remained with him to the end of his career and resulted in extensive collections and in descriptive monographs that rank among the major contributions to American paleontology. Mr. Springer's magnificent collection and his library of crinoid literature have been housed for a number of years in the U. S National Museum and were given by him to the Museum.

Professor MILTON WHITNEY, a member of the ACADEMY and for more than thirty years Chief of the Bureau of Soils, Department of Agriculture, died November 11, 1927, in his 67th year. He was born in Baltimore, Maryland, and was educated in the schools of that city and at Johns Hopkins University. Before taking charge of the Bureau of Soils he was attached to Agricultural Experiment Stations in Connecticut, North Carolina, South Carolina, and Maryland, and was Professor of Agriculture at the University of South Carolina. His numerous publications deal with soil physics and other problems connected with soils.

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